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PHYSICS ABSTRACTS

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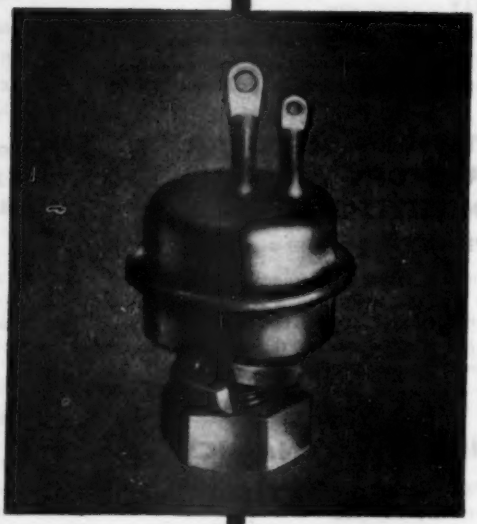

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CX10/100	100	10	0·1	CX5/100	100	5	0·1
CX10/150	150	10	0·1	CX5/150	150	5	0·1
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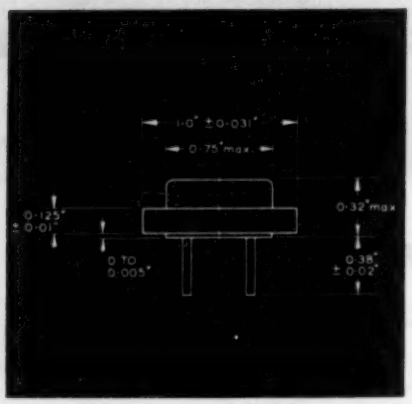

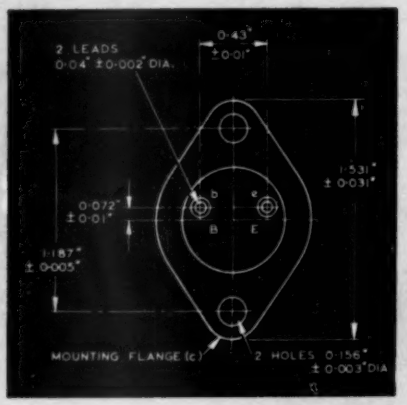

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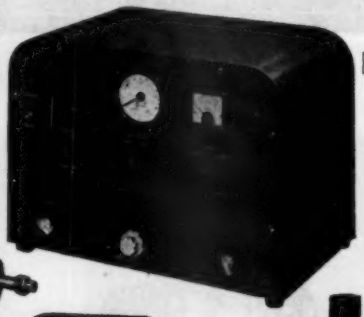

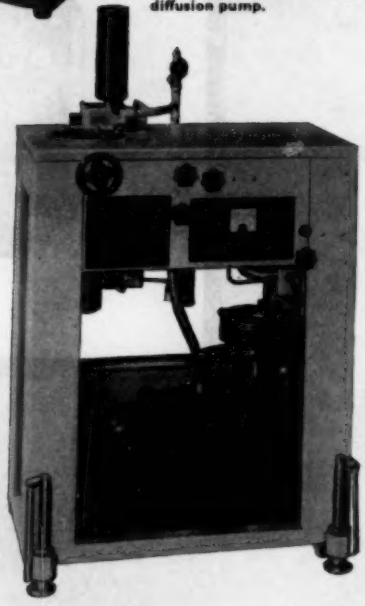

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PHYSICS ABSTRACTS

Volume 63 MARCH 1960 Number 747

MATHEMATICS

517

2066 ON A THEOREM FOR ESTIMATING EIGENVALUES. H.Fujita and T.Kato.

J. Phys. Soc. Japan, Vol. 13, No. 2, 215-19 (Feb., 1958).

Elementary proof is given for a theorem estimating eigenvalues of linear transformations with the form T^*T, which has been used in calculating the fundamental frequency of a square plate with free edges.

517.5

2067 SPECTRAL METHODS IN THE BOUNDARY VALUE PROBLEMS OF MATHEMATICAL PHYSICS. A.Boigelot.

Mem. Soc. Roy. Liege(Ser.5), Vol.2, No.1, 7-98 (1959). In French.

Spectral operators are introducedwhich provide an abstract unified treatment for Dirichlet–Neumann problems associated with the metaharmonic, wave and diffusion equations. R.A.Newing

518.5 : 539.17

2068 ANALOGUE COMPUTERS AND NUCLEAR PLANTS. V.Svelto.

Energia nucleare, Vol. 6, No. 12, 763-8 (Dec., 1959). In Italian.

The basic components of an analogue computer are reviewed, with particular care being given to the required precision. The principal problems that are being dealt with in the nuclear field and the range of the minimum number of fundamental components sufficient for the solving of typical problems which are encountered in the study of power reactor regulation are shown.

518.5

2069 USE OF RACAH ALGEBRA IN EVALUATING COMMUTATORS. M.J.Englefield.

Canad. J. Phys., Vol. 38, No. 2, 315-17 (Feb., 1960).

519

2070 FRAGMENTATION OF GLASS PLATES. U.S.Nigama.

Proc. Nat. Inst. Sci. India A, Vol. 21, No. 3, 161-4 (May 28, 1955).

A number of experiments were performed with plates of varying sizes to discover the basic features of such fragmentation process. The mathematical theory of the random fragmentation (division) of a line into a finite number of N parts has been discussed by several authors (Auluck and Kothari, 1954), and the results of the experiments were broadly in accordance with the theory. It has applications in assessing the randomness of radioactive disintegrations and cosmic-ray events.

ASTROPHYSICS

522.6 : 77

STELLAR PHOTOMETRY STUDIES USING EMULSION THICKNESS VARIATION. See Abstr. 1049

523

2071 THE PRESENT STATE OF DIRAC'S COSMOLOGICAL HYPOTHESES. P.Jordan.

Z. Phys., Vol. 157, No. 1, 112-21 (1959). In German.

Dirac's two hypotheses about variation of the constant of gravitation and of the mass of the universe are discussed with regard to the remarks made by Fierz concerning the author's attempt to give a coherent theory leading to Dirac's two cosmological laws as its consequences. Though at first sight it seems that the results of Fierz would be contrary to the idea of any inconstancy of the mass of the universe, they do not make impossible a theory allowing separate three-dimensional spaces to unite and to add their masses. A direct measurement of the variation of the constant of gravitation is not yet possible, but further progress of methods of measurement probably will allow a direct examination of this hypothesis. Many facts in the realm of geology and geophysics, and concerning the structure and history of the moon, indicate very strongly that diminution of the constant of gravitation during the development of the universe is an empirical fact. At the other hand Ambarzumian's results about formation of stars and galaxies strongly support the idea that these processes may be interpreted at the basis of uniting spaces.

523.1

2072 COSMIC THUNDERSTORMS. C.E.R.Bruce.

J. Franklin Inst., Vol. 268, No. 6, 425-44 (Dec., 1959).

Applications of the author's electrical discharge theory of some astrophysical phenomena are discussed, and interrelationships are adduced between corresponding physical processes in the laboratory and in the terrestrial, stellar and galactic atmospheres. The building-up of electrostatic fields in these atmospheres is discussed, and the breakdown of these fields in electrical discharges is shown to account for the light emission from, and gas movements in, the atmospheres of the long-period variable and combination-spectra stars. The theory has a bearing on the evolutionary process in, and chemical composition of, late-type stars. It will explain the gas movements observed in extra-galactic radio sources, and accounts for the magnetic fields and "relativistic" electrons required by the synchrotron theory of the radio noise itself. The theory likewise suggests an explanation for the existence in some galaxies of two stellar populations, which is in agreement with observations of some of their major features. A new theory of propagation of these cosmic electrical discharges is put forward which offers a way out of the difficulty hitherto met in explaining the short time lags of some magnetic storms on the causative solar outbursts, and the correspondingly high average velocities of the particles responsible for these storms. These are much greater than any velocities so far observed at or near the sun's surface. It is shown that in these large cosmic electrical discharges thermonuclear reactions become important when the discharge temperature reaches about 4×10^6 °K.

523.11

2073 CURRENT PROBLEMS IN THE EXTRAGALACTIC DISTANCE SCALE. A.Sandage.

Astrophys. J., Vol. 127, No. 3, 513-26 (May, 1958).

In principle, a decision between the simplest cosmological models (exploding cases with $\Lambda = 0$, $k = +1, 0, -1$, or the steady-state case) is possible from the observed velocity-distance relation. Two numbers are needed. These are H and the deceleration parameter, $\bar{R}_0/R_0H^2$. This paper discussed the determination of H. Problems connected with the use of cepheid variables as distance indicators are discussed. Because of a finite width of the instability region for cepheids in the colour-magnitude (C-M) diagram, intrinsic scatter in the period-colour and period-luminosity (P-L) relation is expected. The observed period-colour relation at median light for

field cepheids in our Galaxy shows that Eggen's type C variables are oscillating in a higher mode than cepheids of Eggen type A, B. The data show $Q_{A,B}/Q_C \cong 1.9$. If the region of instability for cepheids in the C-M diagram has a width of $\Delta(B-V) = 0.2$ mag, then the P-L relation is expected to have a scatter of 1.2 mag. The intrinsically bluest cepheids should be the brightest. Arp's two-colour data for cepheids in the SMC confirm these predictions. The brightest stars are discussed as distance indicators for galaxies beyond the local group. It is probable that knots identified by Hubble as brightest stars in more distant resolved galaxies are really HII regions. From data in M100, the stars appear to be 1.8 mag. fainter than the knots. This correction, together with a correction of 2.3 mag. to Hubble's moduli for galaxies in the local group, suggests a total correction of about 4.1 mag. to the 1936 scale of distances. This gives $H \cong 75$ km/sec 10^6 pc or $H^{-1} \cong 13 \times 10^9$ years, with a possible uncertainty of a factor of 2. The connection of this value of H with the time scale of exploding cosmologies is briefly discussed.

523.11 : 530.12

2074 GENERAL RELATIVISTIC CONSIDERATIONS ON COSMOLOGY. H.Hönl and H.Dehnen.

Z. Phys., Vol. 156, No. 3, 382-98 (1959). In German.

Section A: The Einstein–Friedmann equations are used to express the age t of the universe as a function of the Hubble constant H and the mean mass density ρ. With Sandage's recent estimate of H (see preceding abstract) and an estimate of t derived from the relative abundances of uranium isotopes, it is concluded that ρ is about 5×10^{-29} gm/cm^3 and implies a closed universe. Section B: A bipolar static solution of the field equations, with non-zero cosmological constant, is set up for a closed model universe with matter concentrated towards the poles. Mach's principle is discussed with reference to this solution. R.A.Newing

523.11

2075 ORIGIN OF HELIUM IN THE MILKY WAY. S.Temesváry and S.v.Hoerner.

Z. Astrophys., Vol. 49, No. 1, 30-41 (1960). In German.

From an investigation of the observed mass fractions of helium, of white dwarfs and of the interstellar matter, the following results are obtained: (1) The rate of star formation must have been much higher during the first stage of the Galaxy than it is today. (2) The amount of interstellar matter which up to now has not participated in star formation should be relatively small. (3) If nearly all existing interstellar gas is, as the white dwarfs, a remnant of bygone stars, it may be supposed also that all helium is star-born.

523.16

2076 THE FREIBURG RADIO [SOLAR] SPECTROGRAPH. (48-165 Mc/s).

K.O.Kiepenheuer and H.H.Rabben.

Z. Astrophys., Vol. 49, No. 1, 61-7 (1960). In German.

Six wide-band dipole systems in azimuthal mounting feed six r.f. amplifiers and mixers, which are alternatively connected with 3 i.f. amplifiers. The total spectrum is scanned twice a second and recorded on film by a treble oscillograph. Two sample records are presented.

523.6

2077 THE ORIGIN OF THE CONTINUOUS SPECTRUM OF COMETS. L.Houziaux.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 45, No. 3, 218-38 (1959). In French.

Four different mechanisms are discussed in relation to experimental data derived from observations of the bright comets: 1948 I; 1949 IV; 1956 h; and 1957 d. Of these, it is considered improbable that diffuse reflection from the cometry nucleus contributes significantly to the continuous spectrum. And since neither Rayleigh nor Thomson scattering is likely to be of major importance in the production of the spectrum of the cometry head, it is considered that the responsible mechanism is scattering by solid particles of radius $\sim 0.36\,\mu$. D.R.Barber

523.74

2078 CONTRIBUTIONS TO THE THEORY SOLAR GRANULATION.

L.Biermann, R.Kippenhahn, R.List and S.Temesváry.

Z. Astrophys., Vol. 48, No. 3, 172-88 (1959). In German.

Numerical calculations of several models for the hydrogen convection zone of the sun show that the observed size of the granulae is of the order of the scale height for the layer in which originate. The propagation of distortions due to the granulation into the outer layers of the sun is discussed. The case of hydromagnetic waves across a horizontal magnetic field is studied in detail.

523.72 : 551.5

SOLAR PROTONS AS THE CAUSE OF DISTURBANCES AT HIGH LATITUDES. See Abstr. 1989

523.74

2079 THE CHARACTER OF THE NEXT SUNSPOT MAXIMUM. W.Gleissberg.

Z. Astrophys., Vol.49, No.1, 25-9 (1960). In German.

The probability laws of sunspot variations, which have yielded successful predictions for the last two sunspot cycles, lead to the conclusion that the next sunspot maximum will very probably be weak. For, it can be expected with a probability of 0.95 that, during the next eleven-year cycle, the smoothed monthly averages of the relative sunspot numbers will not exceed 87.7.

523.75

2080 PROPAGATION OF ELECTROMAGNETIC WAVES IN THE SOLAR CORONA TAKING INTO ACCOUNT THE INFLUENCE OF THE MAGNETIC FIELD.

V.L.Ginzburg and V.V.Zheleznyakov.

Astron. Zh., Vol. 36, No. 2, 233-46 (1959). In Russian.

The problem of propagation over a sunspot with a strong magnetic field is considered, together with some other cases. The conditions of radiation loss from the corona as a result of the interaction of normal waves and their scattering on electron density fluctuations are discussed. A.Tybulewicz

523.75

2081 OBSERVATION OF CHROMOSPHERE ON THE SOLAR DISC AND AT THE EDGE, IN THE K-LINE RADIATION OF IONIZED Ca, WITH AN INTERFERENCE-POLARIZATION FILTER.

S.B.Ioffe, N.M.Drichko, I.A.Prokof'eva and V.M.Sobolev.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 796-7 (Aug. 1, 1959). In Russian.

Presents three photographs obtained at Pulkovo, using a horizontal solar telescope in conjunction with a newly developed (Ioffe and Drichko) interference-polarization filter with a transmission band of about 0.5 A. See also Gil'varg, Distler and Makarova (Abstr. 6930 of 1955) and Dunn [Astron. J., Vol. 58, No. 2, 38 (1953)]. F.Lachman

523.75

2082 RADIO HELIOGRAMS AND CORONA INTENSITY. M.Waldmeier.

Z. Astrophys., Vol. 48, No. 3, 163-71 (1959). In German.

A comparison is made between two-dimensional radio heliograms and optical observations of the corona in the line 5303 A. As both these observations refer to the same level of about 20-50 000 km above the photosphere, a close connection between the source-regions of the radio and the optical coronal radiation may be expected. It is shown that in general the optical coronal emission indeed reveals a better conformity with radio-sources than sunspots and plages. If, however the connection is not satisfactory in every respect, one has to consider that the radio heliogram represents an instantaneous picture, whereas the coronal map has to be built up from observations extending over several days.

523.75

2083 OBSERVATION OF SURGES, FILAMENTS AND CHROMOSPHERIC STRUCTURE IN INTEGRATED LIGHT. U.Becker.

Z. Astrophys., Vol. 48, No. 3, 189-202 (1959). In German.

The contrast against the undisturbed photosphere was never more than a few percent. The observed markings were colourless and blurred. Their visibility does not seem to change from centre to limb. The effect is likely to be caused by the scattering of free electrons.

523.75

2084 TYPE III SOLAR BURSTS AND THEIR RELATION TO ERUPTIONS. H.H.Rabben.

Z. Astrophys., Vol. 49, No. 2, 95-110 (1960). In German.

136 burst events were recorded with the Freiburg radio spectrograph in a period of 200 hr. Their relation to 372 flares observed in the same period is studied. Using records obtained at other

observatories, the spectral range was extended down to the microwave region. About 20% of the flares coincided with type III bursts. 88 of the remaining 96 burst events occurred within the lifetime of flares extended by ±5 min. The following facts were established: (a) The greater the flare importance, the greater the number of bursts per event. (b) Great burst events obviously occur near the onset of a flare, while the occurrence of smaller events is independent of the flare's phase. (c) Burst intensity and frequency drift per sec are independent of the flare importance. (d) Number of bursts per event, intensity of burst and frequency drift per sec increase with the total spectral range of the burst. (e) The centre–limb decrease of the number of bursts exceeds that of flares and in addition shows a strong east–west asymmetry. (f) The contribution of bursts of medium intensity and frequency drift per sec increases strongly with central meridian distance. (g) The radio-efficiency of flares increases with importance. (h) Burst-producing flares prefer certain centres of activity.

523.62

2085 THEORY OF ASTRONOMICAL SCINTILLATION. I. H.Elsässer and H.Siedentopf.

Z. Astrophys., Vol. 48, No. 3, 213-30 (1959). In German.

The passage of visible starlight through the turbulent earth atmosphere is studied by means of geometrical and wave optics. In contrast to the hitherto published investigations the scintillation phenomena are treated as resulting from the influence of the whole atmosphere. This is made possible by the assumption of a model atmosphere which consists of many turbulent layers one upon another. The changes in brightness and direction of the light from stars near the zenith are discussed on the basis of a geometrical theory. By comparison of the brightness scintillation at sea-level with that observed at an altitude of 3600 m on Jungfraujoch an exponential decrease of the fluctuations in the index of refraction n with increasing height in the atmosphere is derived. The calculated r.m.s. fluctuation $\sigma(n)$ at sea-level lies between 0.3×10^{-6} and 1.3×10^{-6}; the equivalent fluctuation in temperature is $0^\circ.03 < \sigma(T) < 0^\circ.13$. The main contribution to the changes in brightness comes from atmospheric layers near 8 km above sea-level, whereas the contributions to the changes in the direction of the incident light decrease exponentially with increasing height.

523.83

2086 INVESTIGATIONS OF ROTATING STARS. III. MERIDIONAL CIRCULATIONS IN THE CASE OF NON-RIGID ROTATION. N.Baker and R.Kippenhahn.

Z. Astrophys., Vol. 48, No. 2, 140-54 (1959). In German.

For Pt I, see Abstr. 8569 (1958). The order of magnitude of meridional velocities in the outer regions of the radiative equilibrium zone is discussed for a non-uniformly rotating star. The case $\omega = \omega(s)$ is first considered, where $s = r \sin\theta$ is distance from the axis of rotation, and meridional velocities are shown to be much greater than for uniform rotation except when ω is of the form $(a + bs^{-2})^{\frac{1}{2}}$. The existence of meridional circulation is established for the general case $\omega = \omega(r,\theta)$, and the associated velocities are again found to be greater in general than for uniform rotation.

R.A.Newing

523.85

2087 THE INTERACTION BETWEEN CLUSTERS OF NEBULAE. K.Just.

Z. Astrophys., Vol.49, No.1, 19-24 (1960). In German.

The low velocity dispersion shown by clusters of galaxies has led to Zwicky's supposition [Publ. Astron. Soc. Pacific, Vol.69, 518 (Dec., 1957)] that Newton's force does not act among them in its full strength. That means that no difficulties arise in the case of Newton's or Einstein's theories, but only in the application of statistical mechanics to the universe.

523.85 : 537.59

COSMIC RAY EXCHANGES BETWEEN GALACTIC HALO AND CENTRE. See Abstr. 1324

523.87

2088 AN ESTIMATE OF THE OPTICAL THICKNESS OF A SPHERICALLY SYMMETRIC, NON-CONSERVATIVE SCATTERING ATMOSPHERE. K.K.Sen.

Proc. Nat. Inst. Sci. India A, Vol. 21, No. 4, 241-3 (July 20, 1955).

A method of estimating the optical thickness of extensive stellar atmosphere is considered for the case of spherically symmetric, non-conservative isotropic scattering. Different percentages of scattering have been taken into account, and it is shown how the thickness of the atmosphere is dependent on the value of the albedo for scattering.

525

2089 A DISCUSSION ON OBSERVATIONS OF THE RUSSIAN ARTIFICIAL EARTH SATELLITES AND THEIR ANALYSIS.

Proc. Roy. Soc. A, Vol. 248, 3-87 (Oct. 28, 1958).

This conference was held at the Royal Society on 29th November, 1957 and consisted of a collection of fifteen papers on the British observations made of Sputniks I and II, and II's carrier rocket casing, by optical, radio and radar methods. See also Abstr. 1457-62 (1958).

525

2090 LUNAR AND SOLAR PERTURBATIONS ON SATELLITE ORBITS. E.Upton, A.Bailie and P.Musem.

Science, Vol. 130, 1710-11 (Dec. 18, 1959).

Calculations of the solar and lunar effects on highly eccentric satellite orbits show that the sun and the moon may cause large changes in perigee height over extended periods of time. The amplitude and sign of the perigee height variations depend on the orbit parameters and the hour of launch; for a typical orbit and various choices of launch time, the perigee height will either rise or fall at the rate of 1 km/day over the course of several months. These results may be significant in deciding the launch conditions for future satellites with highly eccentric orbits.

525

2091 TRIANGULATION — A PRECISE METHOD FOR SATELLITE TRACKING.

P.G.Kirmser and I.Wakabayashi.

J. Franklin Inst., Vol. 268, No. 5, 337-51 (Nov., 1959).

529

2092 THE QUARTZ CLOCKS AT THE PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT AND COMPARISON MEASUREMENTS MADE AGAINST ATOMIC STANDARDS.

A.Scheibe, U. Adelsberger, G.Becker, G.Ohl and R.Süss.

Z. angew. Phys., Vol. 11, No. 9, 352-7 (Sept., 1959). In German.

The five quartz clocks at the P.T.B. are compared with the N.P.L. resonators for the period 1956.0 to 1959.0. Reference to the N.P.L. caesium lamp is included in the survey. Comparison is made with an ammonia maser also over a long period. The quartz clocks exhibit a constant relative frequency drift of between 0.4 and 2.0×10^{-9} per month. Oscillations in the Cs clock are also detected and recorded.

S.Tolansky

PHYSICS

GENERAL

53

2093 UNIVERSAL UNITS OF MAGNETISM, MECHANICS AND TEMPERATURE. A.T.Gresky.
J. Franklin Inst., Vol. 268, No. 5, 388-400 (Nov., 1959).

The ever-increasing accuracy in measurements of fundamental quantities may eventually lead to the establishment of five highly precise "universal units" of magnetic intensity, mass, length, time and temperature. Speculations on the current possibilities for the selection and use of such units are presented. It is proposed that these hypothetical units may permit the revelation of many new universal constants of major importance to fundamental theory and to causal resolutions to several problems of physics. Suggested practical values for new units are: magnetic intensity unit M = 1.842 53 g; mass unit m = 217.699 g; length unit r = 1.615 62 cm; time unit t = = 0.538 912 sec; temperature unit $^{\circ}$T = 0.070 868 1 deg A.

53 : 539.12

2094 NEW METHOD FOR THE EVALUATION OF h/e FROM THE QUANTUM LIMIT OF THE CONTINUOUS X-RAY SPECTRUM. K.Ulmer.
Phys. Rev. Letters, Vol. 3, No. 11, 514-16 (Dec. 1, 1959).

A careful analysis of the factors affecting the shape of the spectral intensity curve near the short wave limit shows that the correct threshold position is where the intensity reaches half the maximum, rather than the point of maximum bending. This enables some twenty-year-old discrepancies between different methods of determining h/e to be removed. J.Hawgood

GRAVITATION . RELATIVITY

530.12

2095 ON THE ASYMMETRIC METRIC. R.Bkouche.
C.R. Acad. Sci. (Paris), Vol. 249, No. 22, 2282-4 (Nov. 30, 1959). In French.

A general study of the bilinear form g(x,y) in n-space. Equivalent bilinear forms are defined and various algebraic theorems are established. R.A.Newing

530.12

2096 THE EQUATIONS OF MOTION OF PARTICLES IN THE UNIFIED FIELD THEORY OF EINSTEIN (1953).
V.V.Narlikar and B.R.Rao.
Proc. Nat. Inst. Sci. India A, Vol. 21, No. 6, 409-15 (Nov. 26, 1955).

It has been shown that mass particles carrying charges can be represented in the 1953 version of Einstein's unified field theory provided each particle singularity is surrounded by a continuous distribution of charge. The equations of motion worked out according to the technique developed by Einstein and Infeld in 1949 for a pure gravitational field reveal the gravitational interaction as well as the expected Coulomb force.

530.12

2097 A GRAVITATIONAL FORCE FUNCTION FOR THE EARTH REPRESENTING ALL DEVIATIONS FROM A SPHERICAL GEOID. R.H.Wilson, Jr.
J. Franklin Inst., Vol. 268, No. 5, 378-87 (Nov., 1959).

Each area of deviation from a uniform spherical gravitational field is represented by a separate series of Legendre polynomials having its pole of reference centred on the area. Thus the earth's north and south polar oblateness deviations are represented separately so that their inequality can be investigated. The series for minor deviations centred at general latitudes and longitudes has been transformed to terms of variables in the inertial coordinate system for practical computation. The vector sum of these expressions for the earth's spherical gravitational field and its deviations, together with explicitly presented geocentric expressions for the fields of the moon and sun, would thus constitute a complete force function for satellite orbit development by numerical integration.

530.12

2098 ON THE QUANTIZATION OF THE GRAVITATIONAL FIELD FOR A SPACE-TIME OF CONSTANT CURVATURE. A.Lichnerowicz.
C.R. Acad. Sci. (Paris), Vol. 249, No. 22, 2287-9 (Nov. 30, 1959). In French.

A correction is made in a result previously derived for a quantization procedure in Minkowski space-time (Abstr. 1019 of 1959) and results are extended to the case of an Einstein space. Commutation conditions are formulated for $H_{\alpha\beta,\lambda\mu}$ in the case of constant curvature. R.A.Newing

530.12

2099 ACTIVE GRAVITATIONAL MASS. C.W.Misner and P.Putnam.
Phys. Rev., Vol. 116, No. 4, 1045-6 (Nov. 15, 1959).

In his book: Relativity, Thermodynamics, and Cosmology (Oxford: Clarendon Press, 1934), p. 272, Tolman states that "... disordered radiation in the interior of a fluid sphere contributes roughly speaking twice as much to the gravitational field of the sphere as the same amount of energy in the form of matter". The gravitational pull exerted by a system on a distant test particle might therefore at first sight be expected to increase if within the system a pair of oppositely charged electrons annihilate to produce radiation. This apparent paradox is analysed here in the case where gravitational effects internal to the system are unimportant. It is shown that tensions in the wall of the container compensate the effect mentioned by Tolman so that the net gravitational pull exerted by the system does not change.

530.12

2100 PROPAGATION LAWS FOR NULL AND TYPE III GRAVITATIONAL WAVES. R.K.Sachs.
Z. Phys., Vol.157, No.4, 462-77 (1960).

Several algebraic characterizations of vacuum type III fields are discussed. A covariant integral conservation law is obtained by introducing a divergence free vector density that is uniquely determined by the metric Riemann tensors of a type III metric. In a region where the gravitational field is of type III almost everywhere, the vector density vanishes at a point if and only if the Riemann tensor vanishes there. The conserved quantity has the dimensions of energy but is probably not simply related to energy in the ordinary sense. The conservation law is interpreted as a Huyghen's principle for an intensity measured by measuringthe relative accelerations due to the gravitational field. It is compared with a previously derived action conservation law for a classical general relativistic electromagnetic field and with a covariant action conservation law that is valid in null (degenerate type II) metrics. Further propagation laws for null and type III waves are given under the assumption that the wave vector is hypersurface orthogonal. It is shown that in linear approximation the far and semi-far fields of a radiating quadrupole are null and type III, respectively; the form of the conservation laws in these linearized metrics is discussed. A "strongly" conserved form of the tensor of Bel and Robinson is suggested (see, for example, Abstr. 1020 of 1958).

530.12

2101 THE GRAVITY FIELD OF A PARTICLE. C.Darwin.
Proc. Roy. Soc. A, Vol. 249, 180-94 (Jan. 1, 1959).

Einstein's equations for the orbits round an attracting point mass, here called the sun, are examined so as to see whether there are orbits which end in the sun, as there are in the corresponding case of electrical attraction when relativity is allowed for. With the measure of the radius as usually taken, it is shown that no hyperbolic orbit can have perihelion inside r = 3m, and an elliptic orbit cannot have perihelion inside r = 4m. Particles going inside these distances will be captured. Circular orbits are possible for any greater radius. If $3m < r < 4m$ the orbit is unstable; with one disturbance it falls into the sun, with the opposite it escapes in a spiral to infinity. If $4m < r < 6m$, it is also unstable, either falling into the sun, or moving out to some aphelion at a greater radius before returning to its circle. Only if $r > 6m$ is the orbit stable. A study is made of the travel of light rays. No light ray from infinity can escape capture unless its initial asymptotic distance is greater than $3\sqrt{3}\,m$. A field of stars surrounds the sun, and

is viewed in a telescope pointed at the sun from a distance. If the field as seen is mapped as though in a plane through the sun, each star, in addition to its direct image, will show a series of faint "ghosts" on both sides of the sun. The ghosts all lie just outside the distance $3\sqrt{3}$ m. A few technical details are given about the orbits of the captured particles.

530.12

2102 INVISIBILITY OF THE LORENTZ CONTRACTION. J.Terrell.

Phys. Rev., Vol. 116, No. 4, 1041-5 (Nov. 15, 1959).

It is shown that, if the apparent directions of objects are plotted as points on a sphere surrounding the observer, the Lorentz transformation corresponds to a conformal transformation on the surface of this sphere. Thus, for sufficiently small subtended solid angle, an object will appear — optically — the same shape to all observers. A sphere will photograph with precisely the same circular outline whether stationary or in motion with respect to the camera. An object of less symmetry than a sphere, such as a meter stick, will appear, when in rapid motion with respect to an observer, to have undergone rotation, not contraction. The extent of this rotation is given by the aberration angle $(\theta-\theta')$, in which θ is the angle at which the object is seen by the observer and θ' is the angle at which the object would be seen by another observer at the same point stationary with respect to the object. Observers photographing the meter stick simultaneously from the same position will obtain precisely the same picture, except for a change in scale given by the Doppler shift ratio, irrespective of their velocity relative to the meter stick. Even if methods of measuring distance, such as stereoscopic photography, are used, the Lorentz contraction will not be visible, although correction for the finite velocity of light will reveal it to be present.

530.12

2103 ON THE LORENTZ INVARIANT FORMULATION OF THE CANONICAL EQUATIONS OF MOTION IN POINT MECHANICS. F.Sauter.

Z. Phys., Vol.156, No.3, 275-86 (1959). In German.

By means of the Hamiltonian variational principle it is shown that the canonical equations of the Hamiltonian point mechanics can be written in Lorentz invariant form. Furthermore the Hamilton–Jacobi differential equation is given in invariant form and its equivalence with canonical equations established.

T.R.Carson

530.12

2104 ON ROTATION AND DEFORMATION VELOCITY IN THE THEORY OF RELATIVITY. M.Kohler.

Z. Phys., Vol.156, No.3, 248-55 (1959). In German.

A sharp definition of the concept of rotation of material bodies meets with difficulties in the special theory of relativity because they are not extended rigid bodies in the sense of classical mechanics. By a definition of rotational motion in relativity theory one must from the start take into consideration also the deformability of the body. T.R.Carson

530.12

2105 THE PROBLEM OF MOTION IN GENERAL RELATIVITY. V.V.Narlikar and B.R.Rao.

Proc. Nat. Inst. Sci. India A, Vol. 21, No. 6, 416-27 (1955).

530.12

2106 DYNAMICAL STRUCTURE AND DEFINITION OF ENERGY IN GENERAL RELATIVITY.

R.Arnowitt, S.Deser and C.W.Misner.

Phys. Rev., Vol. 116, No. 5, 1322-30 (Dec. 1, 1959).

The problem of the dynamical structure and definition of energy for the classical general theory of relativity is considered on a formal level. As in a previous paper (Abstr. 5345 of 1959), the technique used is the Schwinger action principle. Starting with the full Einstein Lagrangian in first order Palatini form, an action integral is derived in which the algebraic constraint variables have been eliminated. This action possesses a "Hamiltonian" density which, however, vanishes due to the differential constraints. If the differential constraints are then substituted into the action, the true, nonvanishing Hamiltonian of the theory emerges. From an analysis of the equations of motion and the constraint equations, the two pairs of dynamical variables which represent the two independent degrees of freedom of the gravitational field are explicitly exhibited. Four other variables remain in theory; these may be arbitrarily specified, any such specification representing a choice of coordinate frame. It is shown that it is possible to obtain truly canonical pairs of variables in terms of the dynamical and arbitrary variables. Thus a statement of the dynamics is meaningful only after a set of coordinate conditions have been chosen. In general, the true Hamiltonian will be time dependent even for an isolated gravitational field. There thus arises the notion of a preferred coordinate frame, i.e. that frame in which the Hamiltonian is conserved. In this special frame, on physical grounds, the Hamiltonian may be taken to define the energy of the field. In these respects the situation in general relativity is analogous to the parametric form of Hamilton's principle in particle mechanics.

530.12

2107 EXACT THREE-VARIABLE SOLUTIONS OF THE FIELD EQUATIONS OF GENERAL RELATIVITY.

B.K.Harrison.

Phys. Rev., Vol. 116, No. 5, 1285-96 (Dec. 1, 1959).

In order to trace out with more understanding the consequences of general relativity it is advantageous to have exact solutions of Einstein's field equations which show more detail than the familiar solutions with their high symmetry. In the present investigation, based on the method of separation of variables, all solutions of the field equations for empty space have been found which (1) have the "linked pair" form

$$g_{ij} = \pm\delta_{ij}A_i^2(x^0,x^1)B_i^2(x^0,x^2),$$

and which (2) are nondegenerate—so far as could be determined—in the sense that all the g_{ij} cannot be reduced to functions of only two variables. Other solutions have been obtained from the solutions of the above form by interchange of variables. Explicit expressions are given for all twenty nondegenerate solutions, all apparently new. Of degenerate solutions, ten are presented, not all of them new. All thirty solutions are examined with respect to possible physical and geometrical interpretations.

530.12

2108 COMPLETION AND EMBEDDING OF THE SCHWARZSCHILD SOLUTION. C.Fronsdal.

Phys. Rev., Vol. 116, No. 3, 778-81 (Nov. 1, 1959).

An analytic manifold is found, the most important properties of which are that it is complete and that it contains the manifold of the Schwarzschild line element. It is thus the complete analytic extension of the latter. The manifold is represented as a Riemannian surface in a six-dimensional pseudo-Euclidean space. The subspace $d\varphi = d\theta = 0$ is visualized as a two-dimensional Riemannian surface in a 3-dimensional hyperplane in the six-dimensional space. Although the manifold admits groups of motion isomorphic to the real 3-dimensional rotation group and the one-dimensional translation group, it is impossible to introduce a global time-coordinate in such a way that the latter is realized as translations in time. Hence in any global set of coordinates the gravitational field is nonstationary, although it can be made stationary for $r > 1$ to any desired approximation. The question of what happens to small test bodies reaching the Schwarzschild critical radius is discussed.

530.12

2109 A SIMPLIFICATION OF EXTERIOR EINSTEIN EQUATIONS FOR A GROUP MOVEMENT. C.B.Rayner.

C.R. Acad. Sci. (Paris), Vol. 249, No. 17, 1614-16 (Oct. 28, 1959). In French.

It is shown how the problem of the resolution of the exterior Einstein equations, $R_{\alpha\beta} = 0$, in the stationary case may be reduced to a problem in three dimensions. T.R.Carson

530.12

2110 THE SUPER-ENERGY TENSOR AND THE RIEMANN TENSOR: SINGULAR CASE. R.Debever.

C.R. Acad. Sci. (Paris), Vol. 249, No. 18, 1744-6 (Nov. 2, 1959). In French.

The consideration of the four isotropic vectors associated with the Riemann tensor of spaces with null Ricci tensor, leads to the following results: the trajectories of the multiple isotropic vector are isotropic geodesics; there exist remarkable spaces in the case where they are distinct; one can give the reduced form of the Riemann tensor in the singular case. T.R.Carson

530.12 : 538.3

2111 UNIFORM ELECTROMAGNETIC FIELD IN THE THEORY OF GENERAL RELATIVITY. B.Bertotti.
Phys. Rev., Vol. 116, No. 5, 1331-3 (Dec. 1, 1959).

A cosmological solution of the Einstein–Maxwell's field equations, corresponding to the case of a uniform (that is, covariant constant) electromagnetic field, is derived by means of simple geometrical arguments; the Riemannian manifold it corresponds to is the product of two ordinary surfaces of constant curvature, whose type and radius depend on the values of the cosmological constant and the invariants of the electromagnetic field. The world-lines of charged test particles have also a very simple geometrical meaning.

530.12 : 532.5

2112 GENERAL RELATIVISTIC FLUID SPHERES. H.A.Buchdahl.
Phys. Rev., Vol. 116, No. 4, 1027-34 (Nov. 15, 1959).

Certain well-known results concerning the Schwarzschild interior solution (see Tolman, Abstr. 1548 of 1959) are generalized to more general static fluid spheres in the form of inequalities comparing the boundary value of g_{44} with certain expressions involving only the mass concentration and the ratio of the central energy density to the central pressure. A minimal theroem appropriate to the relativistic domain is derived for the central pressure, corresponding to a well-known classical result. Inequalities involving the proper energy and the potential energy are also considered, as is the introduction of the physical radius in place of the coordinate radius. A singularity-free elementary algebraic solution of the field equations is presented and exact values obtained from it compared with the limits prescribed by some of the inequalities. An answer is given to the question whether the total amount of radiation emitted during the symmetrical gravitational contraction of an amount of matter whose initial energy, at complete dispersion, is W_0 can ever exceed W_0.

530.12

2113 THE CLOCK PARADOX. M.L.Boas.
Science, Vol. 130, 1471-2 (Nov. 27, 1959).

In Minkowski space, a coordinate system can always be chosen so that the straight line (geodesic) joining two events (not on a null line) is either parallel to the time axis or parallel to the space axis. In either case the geodesic has maximum length (time dilation and Lorentz contraction).

530.12 : 523.11

GENERAL RELATIVISTIC CONSIDERATIONS ON COSMOLOGY. See Abstr. 2074

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

530.14

2114 A SUPPLEMENT TO THE PAPER ON "THE PROBLEM OF THREE BODIES IN QUANTUM MECHANICS". S.D.Majumdar.
Z. Phys., Vol. 153, No. 5, 653-4 (1959).

See Abstr. 5526 (1952). A modification incorporating a property of the symmetric rotor functions is considered. W.A.Hepner

530.14

2115 DERIVATION OF THE BINDING ENERGY OF MANY-PARTICLE SYSTEMS FROM THE TWO BODY DENSITY MATRIX. F.Bopp.
Z. Phys., Vol. 156, No. 3, 348-59 (1959). In German.

An expression is obtained for the two particle density matrix in an N-body system, $\langle 12|\rho|1'2'\rangle$, in terms of eigensolutions of a two body operator $h = H_1 + H_2 + H_{12}$, where H_1, H_2 are the one body parts of the total Hamiltonian for particles 1 and 2 respectively, and H_{12} is the interaction between these two particles. If ϕ_n are the eigenstates of h, with energies ϵ_n, ρ can be written in the form

$$\langle 12|\rho|1'2'\rangle = \Sigma_n p_n \phi_n(12)\phi_n^*(1'2'),$$

and the energy in the form $E = \frac{1}{2}N\Sigma_n p_n \epsilon_n$. Exact expressions are given for the ρ_n, from which suitable approximations can be obtained. In the lowest approximation, for the ground state, p_n is taken to be $2/N(N-1)$ for the lowest $N(N-1)/2$ eigenvalues and zero for the others. This gives an approximation to the energy which is a lower bound to the actual energy. The method is applied to the calculation of atomic states. E.J.Squires

530.14

2116 EXTENDED 3-POINT FUNCTIONS IN HEISENBERG'S THEORY. K.Just, I.Hartmann and H.v.Ossowski.
Z. Phys., Vol. 158, No. 1, 39-43 (1960). In German.

Heisenberg's approximation for the wave-function of a fermion (Abstr. 11822 of 1959) is modified by a more extended account for the corresponding function of three field operators. This may also contain a certain type of form factor, although the calculations are made without any dependence on the internal coordinates. The result depends remarkably on the ambiguous sign of the non-linear term in Heisenberg's field equation.

530.14

2117 QUANTUM THEORY AND CRYSTAL PHYSICS. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 45, No. 6, 361-6 (Dec., 1956).

The fundamental notions of quantum theory and thermodynamics indicate that a crystal should be regarded as an assembly of an immense number of oscillators whose energy states are quantized and which form a system in thermodynamic equilibrium. They also indicate that the spectroscopic properties and the thermal behaviour of crystals stand in the closest relation to each other. It is required to discover and enumerate the oscillators of the different sorts comprised in the crystal and to determine their scheme of energy levels. This may be done by methods analogous to those which have proved successful in the field of molecular spectroscopy. The results obtained are in perfect agreement with the observed spectroscopic properties and thermal behaviour of crystals.

STATISTICAL MECHANICS TRANSFER PROCESSES

530.16

2118 ON THE ERGODIC METHODS IN STATISTICAL MECHANICS. P.Caldirola.
Nuovo Cimento, Vol. 14, No. 1, 260-4 (Oct. 1, 1959).

It is claimed that the ergodic approach to statistical mechanics is the most satisfactory one. The author states two possible objections to this approach and claims that they are both easily answered. He reviews the content of various ergodic theorems. 20 references. H.N.V.Temperley

530.16

2119 A DESCRIPTIVE INTRODUCTION TO THE STATISTICAL THEORY OF COMMUNICATION. B.McMillan.
Nuovo Cimento Suppl., Vol. 13, No. 2, 345-52 (1959).

The main problems of communication theory are formulated and related to corresponding problems in conventional statistics. H.N.V.Temperley

530.16

2120 THE STATISTICAL THEORY OF INFORMATION. R.M Fano.
Nuovo Cimento Suppl., Vol. 13, No. 2, 353-72 (1959).

The notion of quantity of information is defined and the content of Shannon's two fundamental theorems is explained. The first shows that the information content of a message can be directly related to the number of code-symbols it contains, the second that coding methods exist such that the effect of random errors can be eliminated with high probability, at the expense of lengthening the message by introducing checking symbols into it. H N V.Temperley

530.16

2121 CODING THEORY. D.Slepian.
Nuovo Cimento Suppl., Vol. 13, No. 2, 373-88 (1959).

A particular case of Shannon's second theorem is proved. Some mathematical results about certain types of code are given. H.N.V.Temperley

530.16

2122 A LINEAR CIRCUIT VIEWPOINT ON ERROR-CORRECTING CODES. D.A.Huffman.
Nuovo Cimento Suppl., Vol. 13, No. 2, 389-96 (1959).

530.16

2123 NOTES ON INFORMATION-LOSSLESS FINITE-STATE AUTOMATA. D.A.Huffman.
Nuovo Cimento Suppl., Vol. 13, No. 2, 397-405 (1959).

A coding device is "lossless" if the input can be uniquely determined if the output is known. Two mathematically distinct types of such device are described, and it is claimed that the most general possible case can be reduced to a combination of these two. H.N.V.Temperley

530.16

2124 APPLICATIONS OF STATISTICAL NOTIONS TO MULTIPATH CHANNELS. P.E.Green, Jr.
Nuovo Cimento Suppl., Vol. 13, No. 2, 406-15 (1959).

Considers the problem of designing a receiver when there is noise, and transmitter and receiver are connected by several paths whose lengths vary in random fashion. A possible solution is considered. H.N.V.Temperley

530.16

2125 NETWORK THEORETICAL AND PHYSICAL LIMITATIONS OF AMPLIFIER NOISE PERFORMANCE. H.A.Haus.
Nuovo Cimento Suppl., Vol. 13, No. 2, 416-29 (1959).

530.16

2126 STATISTICAL FILTERING AND PREDICTION. Y.W.Lee.
Nuovo Cimento Suppl., Vol. 13, No. 2, 430-54 (1959).

Considers the problem of designing a linear filter circuit such that if the input is a given "message" plus a noise, the output shall resemble the message as closely as possible. The criterion of "resemblance" is taken to be that the mean-square error is a minimum and it is shown that this determines uniquely the frequency response of the filter circuit. This determination requires the solution of a Wiener–Hopf integral equation, an explicit solution of which is given. It is shown that the errors can be reduced if one is prepared to accept a time-lag between message and output, but cannot be removed altogether. The problem of "prediction", (extrapolating a given function forward in time) is a special case of this general theory. The minimum mean-square error can be computed in terms of the desired time-interval. H.N.V.Temperley

530.16

2127 "LEARNING" FILTERS, PREDICTORS AND RECOGNIZERS. D.Gabor.
Nuovo Cimento Suppl., Vol. 13, No. 2, 455-66 (1959).

Points out an analogy between a machine which "learns" and an idealized machine which solves the problem (discussed in the preceding abstract) of minimizing the effect of noise on a given signal. H.N.V.Temperley

530.16

2128 TELEVISION COMPRESSION BY "CONTOUR INTERPOLATION". D.Gabor.
Nuovo Cimento Suppl., Vol. 13, No. 2, 467-73 (1959).

Describes a possible method of reducing the bandwidth required for television by using two scanning spots, the rates of scanning and the intensities being programmed in accordance with the arrival of the two spots at the contours of the picture. H.N.V.Temperley

530.16

2129 INTELLIGENT BEHAVIOR IN PROBLEM-SOLVING MACHINES. H.L.Gelernter and N.Rochester.
Nuovo Cimento Suppl., Vol. 13, No. 2, 474-93 (1959).

530.16

2130 APPLICATION OF THE FUNCTIONAL INTEGRATION METHOD TO THE CONSTRUCTION OF THE FUNDAMENTAL SOLUTION OF THE FOKKER–PLANCK–KOLMOGOROV EQUATION. A.A.Beilinson.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 5, 876-9 (Oct. 11, 1959). In Russian.

The state probability density function of a system, excited by a disturbance, $\varphi_i(t)$ with a Dirac correlation function (e.g., white noise) has been obtained for a linear system: $\ddot{y}_i(t) = \varphi_i(t)$. The author uses the functional integration technique for a system which is linear only in the derivatives:

$$\dot{x}_i(t) + B_i[x(t), t] = \varphi_i(t).$$

Since:

$$y_i(t) = x_i(t) + \int_0^t B_i[x(s), s]\,ds,$$

a Fredholm determinant for this, Volterra-type integral equation, can be constructed and a corresponding probability density function formulated. An asymptotic expansion of this function is also derived, following Feynman's method. J.K.Skwirzynski

530.16

2131 EFFECTS OF PARTICLE-PARTICLE INTERACTION ON THE MOMENT OF INERTIA OF MANY-FERMION SYSTEMS. R.M.Rockmore.
Phys. Rev., Vol.116, No.3, 469-74 (Nov. 1, 1959).

It is shown that in the random-phase approximation the effect of particle-particle interaction on the moment of inertia of a many-fermion system moving under periodic boundary conditions vanishes when calculated on the "cranking" model of Inglis (Abstr. 1110 of 1955; 623 of 1957). This result is obtained by performing a unitary transformation on the equivalent Hamiltonian which reproduces the sequence of diagrams given by the random-phase approximation. The close resemblance of the general problem to the soluble model problem of a rotating dense electron gas is exploited in the calculation. This work extends that of Amado and Brueckner (Abstr. 335 of 1960) who demonstrated only that interaction effects cancel in lowest order. The nature of their approximations and the connection to the problem of collective excitations are discussed.

530.16 : 539.2

MANY-PARTICLE APPROACH TO THE ONE-ELECTRON PROBLEM IN INSULATORS AND SEMICONDUCTORS.
See Abstr. 1546

530.16

2132 GROUND-STATE ENERGY AND EXCITATION SPECTRUM OF A SYSTEM OF INTERACTING BOSONS. N.M.Hugenholtz and D.Pines.
Phys. Rev., Vol. 116, No. 3, 489-506 (Nov. 1, 1959).

The properties of a boson gas at zero temperature are investigated by means of field-theoretic methods. Difficulties arising from the depletion of the ground state are resolved in a simple way by the elimination of the zero-momentum state. The result of this procedure when applied to the calculation of the Green's functions of the the system is identical to that of Belyev (Abstr. 6650 of 1958). It is then shown generally that for a repulsive interaction the energy E(k) of a phonon of momentum k, which is found as the pole of a one-particle Green's function, approaches zero for zero momentum, which means that the phonon spectrum does not exhibit an energy gap. The Green's function method is applied to the calculation of the properties of a low-density boson gas. The next order term beyond that calculated by Lee and Yang, and Belyev for the ground-state energy is obtained and the general form of the series expansion is found to be

$$(E_0/\Omega) = \tfrac{1}{2}n^2 f_d\left[1 + a(nf_0^3)^{1/2} + b(nf_0^3)\ln(nf_0^3) + c(nf_0^3) + d(nf_0^3)^{3/2}\ln(nf_0^3) + \ldots\right],$$

where n is the density and f_0 is the scattering length for the assumed two-body interaction between the bosons. The coefficients a and b are independent of the shape of the interaction, and are the only terms thus far calculated. The coefficient b is in agreement with the hard-sphere gas calculations of Wu and of Sawada. A discussion is given of the intermediate-density calculation of Brueckner and Sawada, and certain possible improvements in the method of summing a selected set of higher-order terms are proposed.

530.16

2133 GROUND STATE ENERGY OF BOSE PARTICLE SYSTEM. R.Abe.
Progr. theor. Phys., Vol. 20, No. 6, 785-97 (Dec., 1958).

The ground state energy of the Bose particle system at low densities is investigated by using the method which is based on summing up the terms of the conventional perturbation series giving rise to the lowest order with respect to the density. The summation

is shown to be greatly simplified if the scattering matrix is introduced, and a simple example is demonstrated for the repulsive square well potential by calculating a few terms of the series first directly and secondly with the aid of scattering matrix. The final result is shown to be valid both for weak and strong interactions and the calculation is carried out analytically for some types of potential function. The connection of the present method with the pseudo-potential method and with the Brueckner theory is investigated and some problems associated with the attractive interactions are discussed. (See also following abstract).

530.16

2134 GROUND-STATE ENERGY OF A BOSON GAS. V.Singh.
Phys. Rev., Vol. 116, No. 3, 507-10 (Nov. 1, 1959).

All the diagrams, occurring in a perturbation calculation of the ground-state energy of a boson gas, having at most one excited pair at a time, are summed up using a variational principle, without explicitly writing their individual contributions. In the limit of large volumes the result of Abe (see preceding abstract) is reproduced. It is also found that the total contribution of all the diagrams is finite even though individually some of them are divergent irrespective of the strength of the interaction.

530.1o

2135 THE PAIR DISTRIBUTION FUNCTION OF A SYSTEM OF BOSE HARD SPHERES CALCULATED UP TO THE FIRST ORDER IN a/λ. L.Colin and J.Peretti.
Nuovo Cimento, Vol. 14, No. 1, 233-4 (Oct. 1, 1959).

530.16

2136 FIELD OPERATORS FOR BOSONS WITH IMPENETRABLE CORES. I. EQUATIONS WHICH REPLACE THE COMMUTATION RULES. A.J.F.Siegert.
Phys. Rev., Vol. 116, No. 5, 1057-62 (Dec. 1, 1959).

Field operators representing particles with impenetrable cores cannot satisfy the usual commutation rules. While the customary derivation of the second quantization formalism cannot be applied to the case of particles with nonintegrable interaction potentials, the field operators $\psi(x)$ and $\psi^{\dagger}(x)$ can be defined by a matrix representation which exhibits them explicitly as transformations of functions of N position vectors into functions of $N-1$ and $N+1$ position vectors, respectively. The assumption of impenetrable cores is introduced in this definition by taking the matrix elements which lead to prohibited configurations of position vectors equal to zero. Equations which replace the usual set of commutation rules are derived from this definition for the case of hard sphere interaction. Conversely it is shown that results which follow from the commutation rules in the standard formalism, follow from the new set of equations with the changes obviously required by the assumption of impenetrable spherical cores. For example, the operator for the number of particles in a finite domain has as eigenvalues the non-negative integers not exceeding the largest number of hard spheres which can be placed into the domain.

530.16

2137 STATISTICAL WEIGHT FOR A MANY-PARTICLE SYSTEM WITH ARBITRARY SPIN.
M.Kretzschmar.
Z. Phys., Vol. 157, No. 5, 554-7 (1960). In German.

Yeivin and DeShalit [Fortschr. Phys., Vol. 6, 524 (1958)] derived by combinatorial methods a closed formula for the statistical weight of states with spin T in a system of many particles with spin $\frac{1}{2}$ and spin 1. Here a group theoretical method of derivation is given, which is applicable to more general cases. As an example, the formula of Yeivin and DeShalit is generalized for a system of particles with spin $\frac{1}{2}$, spin 1 and spin $\frac{3}{2}$.

530.16

2138 A NOTE ON THE (RELATIVISTIC) STATISTICAL MECHANICS OF AN ASSEMBLY IN MASS-MOTION.
R.K.Pathria.
Proc. Nat. Inst. Sci. India A, Vol. 21, No. 5, 331-7 (Sept. 26, 1955).

Linear momentum-conservation is applied to an ideal relativistic gaseous assembly in mass-motion. It is shown that the distribution function thus obtained is formally the same as one would obtain in the rest system without conserving the momentum, except for the appropriate Lorentz transformations. The four-vector character of the quantities

$$\left[\vec{P},\ \frac{i}{c}\,(E + pV)\right]$$

is thereby established.

530.16

2139 QUANTUM STATISTICS OF A GAS WITH DIFFERENT ORBIT AND SPIN TEMPERATURES. E.Fick.
Z. Phys., Vol. 157, No. 4, 407-32 (1960). In German.

A system of particles with spin in a magnetic field may possess an orbital temperature T_o different from the spin temperature $T_s(\gtrless 0)$, if it is possible to neglect the energetic interaction between the orbital and the spin system. The calculation of the quantum statistical most probable distribution of identical independent particles on the orbital and spin energy levels yields the introduction of three Lagrange multipliers — according to the fact that the orbital and the spin energy and the number of particles are fixed — representing the orbital and spin temperature and a generalized Planck's "characteristic function". Apart from the Boltzmann approximation being valid in the case of small spin values for $T_o \gg T_o(T_e$ = usual degeneration temperature) and arbitrary $T_s \gtrless 0$, the distribution and the orbital and the spin energy depend on both the temperatures T_o and T_s coming from the principle of exclusion for Fermi or Bose particles. The equations of state are discussed. There are four heat capacities, which possess characteristic peaks. Instead of the well-known temperature independence of the paramagnetism of degenerated conducting electrons one obtains $\chi \sim T_o/T_s$. The behaviour of the Einstein condensation of a Bose gas is considered.

530.16 : 539.11

2140 THE INITIAL-VALUE PROBLEM OF DECAYING STATES. J.Petzold.
Z. Phys., Vol. 157, No. 1, 122-9 (1959). In German.

The probability of decay of a quantum mechanical system is completely determined by the energy spectrum of the initial state. An exponential law of decay is obtained only if the spectrum has a long tail. Since the initial state is spatially localized, the decay energy and decay constant are fixed by the poles of the S-function.

530.16 : 532.7

2141 MOLECULAR TRANSPORT IN LIQUIDS AND GLASSES. M.H.Cohen and D.Turnbull.
J. chem. Phys., Vol. 31, No. 5, 1164-9 (Nov., 1959).

The authors derive, by using simple considerations, a relation between the diffusion constant D in a liquid of hard spheres and the "free volume" v_f. This derivation is based on the concept that statistical redistribution of the free volume occasionally opens up voids large enough for diffusive displacement. The relation is $D = A \exp[-\gamma v^*/v_f]$, where v^* is the minimum required volume of the void and A and γ are constants. This equation is of the same form as Doolittle's (Abstr. 1504 of 1952) empirical relation between the fluidity ϕ of simple hydrocarbons and their free volume. It has been shown [Williams, Landel, and Ferry, (Abstr. 10019 of 1955)] that the Doolittle equation also can be adapted to describe the abrupt decrease in molecular kinetic constants with decreasing temperature that accompanies the glass transition in certain liquids. The result predicts that even the simplest liquids would go through this glass transition if sufficiently undercooled and crystallization did not occur. The problem of transport in actual simple and network liquids is also discussed. It is shown that data on self-diffusion in some simple van der Waals liquids and liquid metals are described satisfactorily by the relation with v^* near the molecular volume for the van der Waals liquids and near the volume of the ion, corresponding to the highest valence state, for the metals.

530.16 : 532.5

STATISTICAL DYNAMICS OF TURBULENT [FLOW OF AN] INCOMPRESSIBLE LIQUID. See Abstr. 926

530.19

2142 ON THE LIMITS OF APPLICABILITY OF THE IMPACT-PARAMETER METHOD.
M.L.Ter-Mikaelyan and B.V.Khachatryan.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1287-9 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York) Vol. 35(8), No. 5, 898-9 (May, 1959).

It is shown that the impact-parameter method gives the same results as perturbation theory in studies of radiation processes.

W.A.Hepner

GENERAL MECHANICS

531.25

2143 EQUIPMENT FOR "WATCHING" PROPAGATING STRESS WAVES. H.Becker.
Rev. sci. Instrum., Vol. 30, No. 12, 1107-9 (Dec., 1959).

The propagation of stress waves generated by impact may be "watched" photoelastically with the use of the simple experimental arrangement described herein. In addition to providing control over the observed progress of the wave, the apparatus makes possible photography of the wave with conventional cameras. The equipment not only is a scientific instrument, but also provides a useful demonstration for instructional purposes.

531.44

2144 SKIDDING FRICTION. THE EFFECT OF HYSTERESIS LOSSES IN TYRE TREAD RUBBER. B.E.Sabey.
Contemporary Physics, Vol. 1, No. 1, 56-61 (Oct., 1959).

Recent work has shown that when well-lubricated rubber slides over a hard surface, as in the case of a tyre on a wet road, a large part of the frictional resistance may arise from energy losses in the rubber as it is deformed by projections in the hard surface and then recovers. These are the so-called hysteresis losses. Evidence suggests that if the associated practical problems can be solved very worthwhile improvements in skidding friction may be obtained by the use of tyres in which the rubber of the tread has much higher hysteresis losses than the normal tyre tread rubber.

MECHANICAL MEASUREMENTS

531.71 : 535.41

MEASUREMENT OF SMALL DISPLACEMENT BY USING NEWTON'S RINGS AND AN OBJECTIVE MICROMETER. See Abstr. 1041.

531.76 : 621.374.32

2145 TIME ANALYZER UTILIZING THE ARGONNE TYPE 256-CHANNEL PULSE-HEIGHT ANALYZER.
J.F.Whalen, J.W.Meadows and C.H.Nelson.
Rev. sci. Instrum., Vol. 30, No. 11, 991-4 (Nov., 1959).

A time analyser has been designed which is capable of utilizing the memory of any multichannel analyser which employs pulse height to time conversion or any similar instrument. The circuit described has been specifically adapted for use with the Argonne type 256-channel analyser. Channel width from 1 μsec to > 38 μsec are possible with a minimum dead time of 38 μsec.

531.76 : 620.172.222

2146 HIGH-FREQUENCY STRAIN GAUGE AND ACCELEROMETER CALIBRATION.
J.S.Nisbet, J.N.Brennan and H.I.Tarpley.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 71-5 (Jan., 1960).

For earlier work see Abstr. 5671 (1958). A method and apparatus are described for calibrating bonded wire resistance strain gauges in the frequency range from 2 to 20 kc/s. The gauges are mounted on an electromagnetically excited longitudinally resonant bar whose amplitude of vibration is measured by an interferometer. Results are given for one type of gauge. Factors affecting the frequency sensitivity relationship of bonded wire strain gauges are discussed. Application for calibration of accelerometers is discussed.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

532.5

2147 NEW PROOF OF A HYDRODYNAMICAL MINIMUM THEOREM AND AN EXTENSION OF ITS RANGE OF VALIDITY. M.Pfisler.
Z. Phys., Vol.156, No.3, 287-92 (1959). In German.

A principle of least dissipation for viscous fluids is established. Conditions for its validity are found to be less restrictive than was assumed in previous deductions of a similar principle.

R.Eisenschitz

532.5

2148 ON SUPERPOSABLE FLOWS.
P.L.Bhatnagar and P.D.Verma.
Proc. Indian Acad. Sci. A, Vol. 45, No. 5, 281-92 (May, 1957).

The condition of superposability is obtained through vectors and the specific case of axi-symmetrical flow is considered. Some general remarks on the possibility of superposition of two axi-symmetrical flows are made and considerations of the possibility of superposition of general rotational flow on the flows due to a vortex, spiral-vortex and vortex-doublet and of irrotational flow on a radial flow in two-dimensions are discussed. In case of the flow due to a vortex, it is found that a family of rotational flows for which the isocurls are concentric circles is superposable on it. In the case of the remaining three flows we find that the contemplated types of flows do not exist.

532.5

2149 PROBLEMS ON THE MOTION OF NON-NEWTONIAN VISCOUS LIQUIDS.
P.L.Bhatnagar and S.K.Lakshmana Rao.
Proc. Indian Acad. Sci. A, Vol. 45, No. 3, 161-71 (March, 1957).

The paper deals with some general considerations in the motion of highly viscous liquids for which the stress-rate of deformation relation is $t_i^j = F_0\delta_i^j + F_1 d_i^j + F_2 d_\alpha^j d_i^\alpha$. The equations of motion, the equations for vorticity and the energy dissipation term are obtained here for a general spatial flow. In the special case of the plane flow, the vorticity equation is free from the cross-viscosity coefficient. This simplifies the study of problems like the addition of two plane motions, consideration of all circulation preserving motions as well as some "semi-inverse" investigations in plane motions of non-Newtonian liquids.

532.5

2150 ADDITION OF AXIALLY SYMMETRIC MOTIONS OF VISCOUS LIQUIDS. S.K.Lakshmana Rao.
Proc. Indian Acad. Sci. A, Vol. 45, No. 6, 418-23 (June, 1957).

Conditions are noted for the addition of two axially symmetric motions of viscous liquids in which the velocities have toroidal as well as poloidal components and characterization relations are obtained for the class of self-additive axially symmetric motions.

532.5

2151 THEORY OF OSCILLATION OF A VISCOELASTIC FLUID IN A CIRCULAR TUBE. G.B.Thurston.
J. Acoust. Soc. Amer., Vol. 32, No. 2, 210-13 (Feb., 1960).

The hydrodynamic theory for the axial sinusoidal oscillation of a viscoelastic fluid in a rigid tube of infinite length and circular cross-section is given. The fluid is assumed to be incompressible. Its properties in sinusoidal shear are described by a complex coefficient of viscosity. An equation for the velocity profile is developed and typical profile curves are presented. Equations for the acoustic impedance per unit length of tube are also obtained. Functions from which the acoustic resistance and reactance are directly obtainable for a wide range of the physical parameters are determined and are presented in graphical form. Viscoelastic media which range from a perfect viscous fluid to a perfect elastic solid are treated.

532.5

2152 A HYDRODYNAMICAL MODEL FOR THE SEDIMENTATION. M.Kawaguti.
J. Phys. Soc. Japan, Vol. 13, No. 2, 209-15 (Feb., 1958).

The flow of a viscous fluid past a sphere in a frictionless circular pipe is investigated by using Faxén's procedure and the results are applied to the problem of sedimentation. Thus was obtained a formula for the sedimentation velocity V in the form: $V/V_0 = 1 - 1.6493\,(d_V/M^3)^{1/3} + 0.7968\,(d_V/M^3)$, where V_0 is the terminal velocity of a particle, d_V the volume concentration and M a constant of order unity which depends on the distribution of sedimenting particles. Although this model is rather rough, it gives as good results as those given by other theories.

532.5

2153 FLOW OF A COMPRESSIBLE FLUID AROUND A CORNER. M.Ray.
Proc. Nat. Inst. Sci. India A, Vol. 21, No. 3, 155-60 (May 28, 1955).

532.5

2154 SPECTRUM OF AXI-SYMMETRIC TURBULENCE IN A CONTRACTING STREAM. Y.V.G.Acharya.
Proc. Indian Acad. Sci. A, Vol. 44, No. 2, 63-71 (Aug., 1956).

The passage of axi-symmetric turbulence in a suddenly contracting stream has been investigated. A form of axi-symmetric tensor suitable for this study has been derived. Assuming that the form of turbulence is initially axi-symmetric, upstream of the contraction, the spectral forms downstream have been given. The ratio of the turbulence levels, on either side of the contraction, has been evaluated in integral form. Further, the integrals have been solved, assuming that the defining scalars are functions only of the wave number κ. The method of evaluating one-dimensional spectra has been indicated. The whole investigation is based on the linearised approach.

532.5

2155 DIFFRACTION WAVES IN THE PROBLEM OF CAUCHY AND POISSON. L.N.Sretenskii.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 1, 59-60 (Nov. 1, 1959).
In Russian.

A deep cylinder is filled with liquid and a vertical plate with a straight edge is immersed. Surface waves are assumed to start from a point. Formulae are derived from which the progress of these waves may be determined, and, in particular their diffraction at the edge. R.Eisenschitz

532.6

2156 A SIMPLIFIED THERMODYNAMIC APPROACH TO CAPILLARITY. I. APPLICATION TO FLOW IN CAPILLARY CHANNELS. II. APPLICATIONS TO CONTACT ANGLE AND SPREADING PHENOMENA. A.M.Schwartz and F.W.Minor.
J. Colloid Sci., Vol. 14, No. 6, 572-83, 584-97 (Dec., 1959).

532.6

2157 FUNDAMENTAL BASIS FOR THE CONTACT ANGLE AND CAPILLARY PRESSURE.
R.E.Collins and C.E.Cooke, Jr.
Trans Faraday Soc., Vol.55, Pt.9, 1602-6 (Sept.,1959).

The principles of the existence of a surface free energy and the minimum of the total free energy of a system at equilibrium are used to derive the classical contact angle equation and the equation for capillary pressure. The effect of gravity acting on the fluids is included in the derivation. The assumptions necessary for the validity of the classical equations are made evident and it is demonstrated that the consideration of body forces such as those due to gravity does not alter the classical equation for contact angle.

532.6

2158 SURFACE AGEING AT LIQUID–LIQUID INTERFACES. I. CALIBRATION OF CONTRACTING JET METHOD.
F.H.Garner and P.Mina.
Trans Faraday Soc., Vol. 55, Pt 9, 1607-15 (Sept., 1959).

An experimental technique based on the contracting jet method of Addison was developed for the study of interfacial ageing in liquid–liquid systems during short time intervals. Addison's theoretical equations for the determination of the dynamic interfacial tension are discussed. Five different pure liquid–liquid systems of the same density and varying interfacial tensions have been selected and jet diameter against interfacial tension calibration charts have been obtained with two different nozzles at jet liquid flow rates of 2.50 and 3.82 ml/sec. The validity of the calibration charts was confirmed and it was shown that the empirical method developed provides a simple means of obtaining relative interfacial tension against time data of reasonable accuracy.

532.6

2159 SURFACE AGEING AT LIQUID–LIQUID INTERFACES. II. EFFECT OF CHAIN LENGTH AND STRUCTURE OF ORGANIC COMPOUNDS IN WATER. F.H.Garner and P.Mina.
Trans Faraday Soc., Vol. 55, Pt 9, 1616-26 (Sept., 1959).

The contracting-jet method was used to study the variation of interfacial tension of aqueous solutions of alcohols, phenols, amines and acids with time and with concentration. Using equations given by Gibbs, Addison, Bond and Puls, and Blair, the maximum surface excess of solute, velocity of migration, diffusion coefficient, and energy barrier to adsorption have been calculated over the range of low concentrations employed. It was shown that in solutions of non-electrolyte surface-active solutes, the time required to attain interfacial tension equilibrium is due not to ordinary diffusion but to a barrier to adsorption which exists at the interface and whose magnitude decreases with increase in the hydrophobic chain length. The overall rate of adsorption is a function only of the chain-length and the structure of the hydrophobic part of the molecule, and the nature or position of the hydrophilic end-group has no direct effect. The velocity V of migration of the solute molecules increases with the hydrophobic chain-length according to the empirical equation $V = \exp(0.6n - 1.4) + 2.5$, where n is the number of carbon atoms.

532.6

2160 ON THE JONES-RAY EFFECT AND THE SURFACE TENSION OF DILUTE SOLUTIONS OF ELECTROLYTES. G.Passoth.
Z. phys. Chem. (Leipzig), Vol. 211, No. 3-4, 129-47 (1959).
In German.

The influence of traces of organic substances (impurities) on the surface tension and Volta potential of solutions of electrolytes is studied. In particular (relative) variation in the surface tension of NaCl and KBr solutions in the concn. range 10^{-3} to 10^{-2} moles per litre is investigated by means of a modified bubble pressure method. It is found that with low bubble frequency the surface tension of water appears first to be lowered by the addition of electrolyte (the Jones-Ray effect) but that at high bubble frequency no such effect exists. The measurements then are in accord with the theory of Onsager and Samaras. The liquid skin on the wall of the capillary affects the effective capillary radius. At low bubble frequency the thickness of this skin is concentration dependent (in agreement with Langmuir's theory) while at higher bubble frequencies the thickness is essentially dependent on the viscosity of the solution and concentration independent. W.Good

532.6

2161 PRECISE MEASUREMENT OF DENSITY AND SURFACE TENSION AT TEMPERATURES UP TO 1000° C IN ONE APPARATUS. G.J.Janz and M.R.Lorenz.
Rev. sci. Instrum., Vol. 31, No. 1, 18-22 (Jan., 1960).

A method for the precise measurement of surface tension and density of molten salts in one apparatus at temperatures up to 1000° C is reported. The essential features of the apparatus are a density bob of special design to enable surface tension data to be obtained simultaneously, and a continuously variable height crucible arrangement for the liquid sample. A description of the apparatus and the calibration procedures are given in detail. The results for molten potassium nitrate up to 470° C are reported to illustrate the method.

532.6

2162 AUTOMATIC RECORDING FILM BALANCE SYSTEM. H.J.Trurnit and W.E.Lauer.
Rev. sci. Instrum., Vol. 30, No. 11, 975-81 (Nov., 1959).

An automatic recording film balance system is described. It consists of a film trough and two pendulum type balances with pressure ranges of 0-400 (800) millidynes/cm and 0-40 (80) dynes/cm, respectively. Each balance is connected to a float when in operation (Langmuir type balance) and the sensing element in both cases is a linear variable differential transformer, the iron core of which is connected to the pendulum. The transformer signal after amplification drives the pen motor of a strip chart recorder. Special features like a constant pressure device together with auxiliary instruments such as a second X-Y recorder, an automatic dipping device for film transfer, a volta potential meter and a slit viscosimeter permit the automatic recording of the following functions:

$$\left(\frac{dF}{dA}\right)_T, \left(\frac{dA}{dT}\right)_F, \left(\frac{dF}{dT}\right)_A, \left(\frac{dF}{dt}\right)_{T,A}, \left(\frac{dA}{dt}\right)_{T,F}, \left(\frac{A_W}{A_S}\right)_{T,F}, \left(\frac{dV}{dF}\right)_T, \text{ and } \left(\frac{d\eta}{dF}\right)_T$$

F = film pressure, A = film area, T = temperature, t = time, A_W/A_S = deposition ratio, η_i = film viscosity, and V = volta potential. Test and performance data are presented.

532.6

2163 PROFILES AND AREAS OF INTERFACES IN THE DU NOÜY RING METHOD.
F.van Zeggeren, C.de Courval and E.D.Goddard.
Canad. J. Chem., Vol. 37, No. 12, 1937-45 (Dec., 1959).

Profiles and areas of interfaces subjected to interfacial tension measurements by the du Noüy ring method, were calculated with the aid of a digital computer. The computations were based on a solution of a set of two simultaneous, first order, ordinary differential equations. Area corrections amounted to from 5 to 17% of the total area calculated on the assumption of planar contact. These correc-

tions permit more precise evaluation of the molecular area of monolayers spread at such interfaces. Two interfaces, benzene–water and hexane–water, were taken as examples. Profiles of curves around the rings were also determined experimentally by means of an electrical contact micromanipulator method. Theoretically computed and measured profiles show very good agreement.

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

532.7

2164 DIFFUSION. METHODS — POSSIBILITIES. APPLICATION TO THE STUDY OF IONIC INTERACTIONS. R.Marignan.
J. Chim. phys., Vol. 56, No. 5, 429-39 (May, 1959). In French.

A general review of recent work on diffusion as applied to the ellucidation of the behaviour of molecular and ionic species in a dispersion medium. Twenty-nine references are given.

G.I.W.Llewelyn

532.7 : 541.15

2165 THE DIFFUSION OF REACTION PRODUCTS FROM A RADIOACTIVE MONOLAYER.
S.G.Mason and W.Rabinovitch.
Proc. Roy. Soc. A, Vol. 249, 90-9 (Jan. 1, 1959).

The one-dimensional diffusion equation has been solved for transfer at an exponentially decaying rate from an area source into a semi-infinite diffusion medium. Numerical values of the concentration distribution are given for a wide range of the values of the parameters. The solutions have been used to calculate the radioactive counting rate of a diffusing radioactive substance which is being released from the surface, assuming exponential absorption of radiation by the medium. The results have been used specifically to calculate the true rate of exchange of radio-iodine between a monomolecular layer of α-iodostearic acid and iodide ion in a water substrate from the measured rate of decay of radioactivity measured at the surface, but have other possible applications.

532.7

2166 SELF DIFFUSION IN LIQUID In–Pb ALLOYS. A.Paoletti and M.Vicentini.
Nuovo Cimento, Vol. 14, No. 4, 748-57 (Nov. 16, 1959).

The self-diffusion coefficients in the liquid alloys In–0.5% Pb and In–1.5% Pb were measured over a wide range of temperatures, using In^{114} and RaD as tracers. The results show, within the experimental errors, the independence of the activation energy of the tracer. This fact is interpreted as an indication of a long range contribution of the atoms to the energy barrier for the diffusion.

532.7 : 530.16

MOLECULAR TRANSPORT IN LIQUIDS AND GLASSES.
See Abstr. 2141

532.7

2167 RELATION BETWEEN DISPERSION AND INTENSITY MEASUREMENTS IN PURE LIQUIDS. P.N.Schatz.
J. chem. Phys., Vol. 31, No. 4, 1146-7 (Oct., 1959).

The relation between dispersion and intensity measurements in pure liquids is discussed and a relation derived between the refractive index and the integrated absorption coefficient.

W.J.Orville-Thomas

532.7

2168 VAPOUR PRESSURE OF ISOTOPIC LIQUIDS. I. A, N_2, O_2 BELOW BOILING-POINT.
G.Boato, G.Scoles and M.E.Vallauri.
Nuovo Cimento, Vol. 14, No. 4, 735-47 (Nov. 16, 1959).

A static equilibrium method was used to measure the single stage separation factor α of isotopic pairs in the vapour liquid equilibrium of A, N_2 and O_2 below boiling-point. Since the corresponding isotopic mixtures are supposed to be ideal, the vapour pressure ratio of the studied isotopic liquids is identical to α. Due to the sensitivity and the precision of the mass spectrometer employed, enriched isotopes were not needed. High purity gases were not necessary since, at least to a certain extent, the adopted method of measurement is insensitive to impurities. The separation factors at the boiling point were found to be the following:

$A^{36}-A^{40}$ $\alpha = 1.0060 \pm 0.0001$,
$O_2^{16}-O^{16}O^{18}$ $\alpha = 1.0050 \pm 0.0001$,
$N_2^{14}-N^{14}N^{15}$ $\alpha = 1.0037 \pm 0.0001$.

The temperature dependence was established in all cases in a relatively narrow range of temperatures. A discussion of the argon results in the light of the quantum theorem of corresponding states is given.

532.7 : 538.3

2169 EXPERIMENTS ON THE INSTABILITY OF A LAYER OF MERCURY HEATED FROM BELOW AND SUBJECT TO THE SIMULTANEOUS ACTION OF A MAGNETIC FIELD AND ROTATION. II. Y.Nakagawa.
Proc. Roy. Soc. A, Vol. 249, 138-45 (Jan. 1, 1959).

For Pt I see Abstr. 594 (1958). Experiments are described which are devoted to the determination of the sizes of the convection cells which appear at marginal stability in a layer of mercury heated from below and subject to the action of a magnetic field either alone or in the presence of rotation. The experiments confirm the theoretical predictions of Chandrasekhar regarding the wave number of the disturbance which is manifested at marginal stability. In particular, under the simultaneous action of magnetic fields and rotation, the present experiments fully confirm the predicted discontinuous change in the wave number at the point where, for increasing field strength (for given rotation), the transition from cellular convection to overstable convection takes place.

532.7

2170 EFFECTS OF γ-RAYS ON AQUEOUS SOLUTIONS OF SYNTHETIC POLYMERS.
S.Sugai, M.Ishikawa and J.Furuichi.
J. Phys. Soc. Japan, Vol. 14, No. 4, 544 (April, 1959).

Changes of viscosity of solutions of sodium carboxymethyl cellulose in water and in methyl alcohol caused by irradiation with Co^{60} γ-rays in the presence of oxygen are recorded. Molecular degradation appears to be the only essential process occurring, and, in dilute solutions, the kinetics are those typical of an indirect effect through the solvent.

C.B.Allsopp

532.7 : 537.2

2171 THE PRINCIPAL DISPERSION REGION IN THE LONG CHAIN ALIPHATIC ALCOHOLS IN THE LIQUID STATE. G.Klages and D.Roth.
Z. Naturforsch, Vol. 14a, No. 7, 628-33 (July, 1959). In German.

Measurements of the complex dielectric constant of six primary aliphatic alcohols with 8 to 18 carbon atoms at 215.6 and 52.0 cm wavelength and from 20 to 70°C. Dielectric activation energies and entropies are discussed in terms of the effect of chain length. Measurements on solutions of decanol in carbon tetrachloride are also reported.

J.G.Powles

532.7 : 537.2

2172 OBTAINING LIQUIDS OF HIGH DIELECTRIC PERMITTIVITY AND OF HIGH RESISTIVITY. N.Félici.
C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 654-5 (Aug. 3, 1959). In French.

It is shown that the low resistivity normally associated with strongly polar liquids, such as acetone and nitrobenzene, is due to electrolytic impurities which cannot be eliminated by the usual methods of purification. A special method of de-ionizing is described by which resistivities of over 10^{10} ohm cm have already been obtained. Potential applications are mentioned.

R.C.Kell

532.7 : 537.2 : 539.2 : 621.315.61

2173 EFFECTS OF GAMMA RADIATION AT 25°C ON SILICONE DIELECTRICS. C.G.Currin.
Trans Amer. Inst. Elect. Engrs I, Vol. 78, 297-308 (1959) = Commun. and Electronics, No. 44 (Sept., 1959).

This is a rather thorough investigation of the effect of radiation from a cobalt-60 source on various silicones. Total irradiation doses ranged up to 1000 Mrad, the rate being of the order of 0.5 Mrad/hr. The materials tested were silicone fluids of various types, compounds, elastomers and resins. Physical and dielectric

properties were measured after different doses, some measurements also being made during irradiation, when transitory effects were found. On the whole, the fluids suffered the most damage, while the silicone resins were least affected. K.W.Plessner

532.7 : 535.3

2174 DETERMINATION OF ABSORPTION COEFFICIENTS FROM INFRARED DISPERSION DATA. R.E.Kagarise.
J. chem. Phys., Vol. 31, No. 5, 1258-61 (Nov., 1959).

Liquid dispersion data in the neighbourhood of the 14μ absorption bands of CCl_4 and the 9μ band of CH_2I_2 have been analysed in terms of the Kramer dispersion equation. The so-called oscillator strengths obtained from the dispersion data were found to be in good agreement with those obtained directly from integrated absorption coefficients. The liquid state absorption coefficients for the 9μ band of CH_2I_2 are essentially equal to that previously reported for the vapour state. Thus it would appear that the Polo–Wilson ratio of intensities is not satisfied in this case.

532.7 : 535.3

2175 ON THE CONNECTION BETWEEN RAMAN SCATTERING, ABSORPTION AND FLUORESCENCE (RESONANCE RAMAN EFFECT). J.Behringer.
Z. Elektrochem., Vol.62, No.5, 544-67 (1958). In German.

The resonance Raman effect occurs when a substance is irradiated in its absorption band, and the effect may be many times as great as the normal effect if disturbance by absorption, fluorescence and photochemical reactions can be eliminated. Detailed theoretical discussions are given of the effect, of the correction required for absorption, and of the relation between the Raman effect and fluorescence. Experiments were made on 73 organic substances, mostly coloured, ranging from simple hydrocarbons to β-carotenes and dyestuffs, which were excited in solution by the Hg lines at 4047, 4358 and 5461 A, and extensive details are quoted. There are also tabulations of the results for nitro compounds and for polyene compounds, and of calculated values of effective and true absorption frequencies. S.T.Henderson

532.7 : 535.33 : 533.7

CONTRIBUTIONS TO THE INTERPRETATION OF INFRARED ABSORPTION SPECTRA OF LIQUID MIXTURES AND COMPRESSED GASES. See Abstr. 974

532.7 : 535.37

2176 COMPARISON OF HIGH-ENERGY AND ULTRAVIOLET-RADIATION INDUCED LUMINESCENCE IN LIQUID SYSTEMS. S.Lipsky and M.Burton.
J. chem. Phys., Vol. 31, No. 5, 1221-6 (Nov., 1959).

Luminescence induced by Co^{60}-gamma excitation of some organic solvent-solute pairs has been compared with 2537 A excitation as to dependence of intensity on solute concentration and on concentration of an added quencher. The solutions studied were 1,6-diphenylhexatriene in benzene, p-terphenyl in benzene, and p-terphenyl in toluene. The quencher was bromobenzene. The energy-transfer parameter Q of the Kallmann–Furst theory and the quenching constant were obtained for each of the systems. Within an estimated experimental error of about 5%, Q was unaffected by change in source of excitation. The efficiency of quenching was found to be greater for Co^{60}-gamma than for u.v. excitation for the two systems involving p-terphenyl. With diphenylhexatriene as solute, however, the quenching constant was unchanged. These results argue against a mechanism of energy exchange involving charge transfer. The high rates of transfer and quenching are consistent with a picture of the solvent involving the existence of small ordered regions within which exciton transfer can occur so that the entire region is viable to attack by a foreign molecule with resultant quenching or energy transfer.

532.7 : 535.37

2177 QUENCHING EFFECTS AND THE AFTERGLOW OF CHLOROPHYLL.
H.O.Albrecht, W.C.Denison, L.G. Livingston and C.E.Mandeville.
J. Franklin Inst., Vol. 268, No. 4, 278-82 (Oct., 1959).

The weak light-emission of Chlorella pyrenoidosa about 4 sec after illumination by photosynthesizing blue light shows an apparent partial quenching when radiation at 7000 A is simultaneously applied. This result accords with the present view that this afterglow arises from the thermal release of electrons trapped in a crystalline structure of chlorophyll. The "quenching" radiation would provide optical release. Phosphorescence excited by longer wavelengths than blue is not quenched, suggesting it to arise by an essentially different mechanism. Chlorophylls and derivatives dissolved in a film of cellulose butyrate show a rather characteristic weak afterglow, often of several minutes half-life, of shorter wavelength than the fluorescence, and which is not certainly a light-induced oxidative chemiluminescence.

532.7 : 535.37

2178 ON THE PHASE RELATION BETWEEN SONOLUMINESCENCE AND THE CAVITATION PROCESS WITH PERIODIC EXCITATION. E.Meyer and H.Kuttruff.
Z. angew. Phys., Vol. 11, No. 9, 325-33 (Sept., 1959). In German.

Cavitation bubbles were produced on the plane end face of a Ni tube 1m long, 12mm in external diameter, dipping into ethylene glycol, when ultrasound at 2.5 kc/s was excited by magnetostriction of the tube. The cavitation was photographed with a spark at any required phase of the cycle, and the luminescence observed by a photomultiplier and oscilloscope. It was shown that the very brief luminescence pulses occur at the moment of collapse of the bubbles, possibly on account of adiabatic heating of the contained gas to high temperatures (~10 000° K). S.T.Henderson

532.7 : 538.27

2179 RELAXATION OF DEUTERIUM NUCLEI IN PARAMAGNETIC SOLUTIONS. A.I.Rivkind.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1007-9 (April, 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 695-6 (Oct., 1958).

The spin relaxation of deuterium nuclei in solutions containing Cr^{3+}, Mn^{2+}, Fe^{3+}, and Cu^{2+}, in heavy water was investigated. The measuring technique is a modified saturation-curve method, in which the degree of nuclear saturation is changed by changing the concentration of paramagnetic ions in solution. The measurements were made at room temperature using a frequency of 2.6 Mc/s. It was found that

$$T_{1d}/T_{1p} = \alpha(\gamma_p^2/\gamma_d^2)$$

where T_{1p} and T_{1d} are the longitudinal relaxation times for protons in water solutions and deuterons in heavy-water solutions respectively, γ_p and γ_d are the appropriate gyromagnetic ratios, and α is a numerical constant which has the values: ~ 4.2 for Cr^{3+}, Fe^{3+}, and Cu^{2+}, and ~ 6.8 for Mn^{2+}. The difference in the value of α for Mn^{2+} is discussed. It was also found that T_1 increases with the formation of complexes in solution and that $T_1/T_2 \gg 1$, (T_2 is the transverse relaxation time) and the values of T_1/T_2 are in the ratio $Cu^{2+}:Cr^{3+}:Fe^{3+}:Mn^{2+}$, in agreement with theory. S.A.Ahern

532.7 : 538.27

2180 NUCLEAR MAGNETIC RESONANCE SHIFT IN MOLYBDENUM. S.I.Aksenov.
Zh. eksper teor. Fiz., Vol. 35, No. 1(7),300-1 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York) Vol. 35(8), No. 1, 207-8 (Jan., 1959).

The Knight shifts of Mo in an aqueous solution of K_2MoO_4 were found to be:

$$\Delta H/H\ (Mo^{95}) = 0.582 \pm 0.005\%$$
$$\Delta H/H\ (Mo^{97}) = 0.586 \pm 0.005\%.$$

Experiments enabled the author to conclude that the effect of quadrupole interaction could be neglected. D.J.Oliver

MECHANICS OF GASES

533.6

2181 THE STEADY COMPRESSIBLE LAMINAR BOUNDARY LAYER, WITH ARBITRARY PRESSURE GRADIENT AND UNIFORM WALL TEMPERATURE. N.Curle.
Proc. Roy. Soc. A, Vol. 249, 206-24 (Jan. 1, 1959).

An approximate integral of the energy equation is derived by expressing the total temperature as a quadratic function of velocity, the Prandtl number being taken as unity. The three coefficients are chosen to satisfy the two temperature boundary conditions and to give the correct temperature profile in the outer part of the boundary layer. A transformation of the normal coordinate is applied, which partially reduces the momentum equation to an incompressible form. It is shown that in the transformed coordinates the functional

relationships between the skin-friction, pressure gradient and shape parameters should be approximately given by their incompressible forms, the effects of compressibility appearing explicitly in certain additional terms in the equation and implicitly in the transformation. Using these correlations, together with the approximate temperature profile, the momentum equation is reduced to a form whose integration requires only quadratures. The predictions of the theory are compared with three exact solutions. These indicate that the error in the predicted separation position increases with Mach number and is about 20 and 40% at Mach numbers of 3 and 4 respectively. The detailed distribution of skin-friction is given with similar accuracy. A tentative empirical correction will probably yield greater accuracy in the prediction of separation, so that the error is only about 10% at a Mach number of 4.

GASEOUS STATE

533.7

2182 DIFFUSION OF GASES IN THE VICINITY OF A CAVITATION BUBBLE. P.Suquet.
J. Phys. Radium, Vol. 18, No. 12, 676-80 (Dec., 1957). In French.

The diffusion of gases towards the liquid phase is observed during the period of contraction of an ultrasonic bubble. To a first approximation, the basic assumption is that the period of the vibratory motion is of sufficiently short order for the geometric centre of the bubble to be considered as immovable with respect to an axial system related to the container.

533.7

2183 SOUND ABSORPTION IN THE HALOGEN GASES. F.D.Shields.
J. Acout. Soc. Amer., Vol. 32, No. 2, 180-5 (Feb., 1960).

Apparatus was constructed for measuring sound absorption by the tube method in corrosive gases at high temperatures. This apparatus was used to measure sound absorption in chlorine, bromine, and iodine vapours at temperatures between 25° and 256°C. The measurements revealed vibrational relaxation absorption peaks in all the gases. In Cl_2 the relaxation times varied from 4.90 μsec at 25°C to 1.55 μsec at 255°C. In Br_2 the variation was from 0.854 μsec at 28°C to 0.460 μsec at 256°C. In I_2 the relaxation time was almost independent of temperature, changing only from 0.106 to 0.102 μsec when the temperature changed from 112° to 253°C. The heights of the absorption peaks were adequately predicted by assuming the relaxing vibrational specific heat to be $C_p - \frac{7}{2}R$. Neither the Schwartz–Herzfeld nor Cottrell–Ream theoretical equations for the relaxation time accurately predict the measured variation with temperature, molecular mass and vibrational frequency.

533.7

2184 APPARATUS FOR THE DETERMINATION OF THE BAND ABSORPTION OF GASES AT ELEVATED PRESSURES AND TEMPERATURES. J.T.Bevans, R.V.Dunkle, D.K.Edwards, J.T.Gier, L.L.Levenson and A.K.Oppenheim.
J. Opt. Soc. Amer., Vol. 50, No. 2, 130-6 (Feb., 1960).

Apparatus for the measurement of the band absorption of gases at pressures up to 10 atm and temperatures up to 1400°K is described. An optical path of 15 in. is maintained with an accuracy of 1% by a nozzle seal system which allows measurements to be made without the use of windows in the high temperature zone. Use of KBr windows for the pressure seal permits measurements to 23μ.

533.7 : 536.23

2185 EFFECT OF ARGON AND HELIUM ON THE THERMAL CONDUCTIVITY OF THE $N_2O_4 \rightleftharpoons 2NO_2$ SYSTEM. K.P.Coffin.
J. chem. Phys., Vol. 31, No. 5, 1290-7 (Nov., 1959).

The effect of dilution by argon and by helium on the thermal conductivity on the dissociating $N_2O_4 \rightleftharpoons 2NO_2$ system was investigated in a hot-wire apparatus. Values of the conductivity were obtained over a pressure range of 0.05 to 1.0 atm at 300°, 320°, and 350°K, (the temperature range where the contribution of the reaction to the conductivity is large). Rigorous calculations of the conductivity were made for the three-component systems. Agreement between experimental and calculated values is generally good. At reduced pressures, experimental results are smaller than the calculated values. A calculation involving reaction rates is shown to predict these low-pressure effect.

VACUUM PHYSICS

533.5

2186 ON THE STREAMING IN THE HIGH VACUUM ("KNUDSEN'S MOLECULAR STREAMING") UNDER THE INFLUENCE OF ADSORPTION AND ABSORPTION. F.Kirchner.
Z. angew. Phys., Vol. 11, No. 5, 167-9 (May, 1959) In German.

Consideration of experiments in which the pressure indicated by vacuum gauges, separated by tubes 10 to 20 cm long and 1 to 2 cm in diameter from sources of alkali metal vapour, was one or two orders of magnitude less than the vapour pressure at the prevailing temperature, has lead to the derivation of an equation of molecular flow for these conditions. In this equation account is taken of both adsorption and absorption by the introduction of the mean times τ_1 and τ_2 between the adsorption of a molecule on to the wall and its subsequent desorption (τ_1) or absorption (τ_2). J.Dutton

533.5 : 541.18

INTERACTION OF ATOMIC HYDROGEN WITH GLASS. See Abstr. 1969

533.5

2187 MOLECULAR PUMPING. J.W.Beams.
Science, Vol. 130, 1406-7 (Nov., 20, 1959).

A method is described for producing high vacua. A magnetically suspended molecular pumping rotor is operated inside a sealed glass vacuum system. The system is free of lubricants and can be baked out. The system gives promise of producing pressures below those previously used.

532.5 : 537.36

ION DRAG PUMPS. See Abstr. 1096

533.5

2188 NONPROPORTIONALITY IN BAYARD–ALPERT IONIZATION GAUGE AND THE ULTIMATE VACUUM DETERMINATION OF DIFFUSION PUMPS. V.Mizushima and Z.Oda.
Rev. sci. Instrum., Vol. 30, No. 11, 1037-41 (Nov., 1959).

The nonproportionality between the ion current and the electron current in a Bayard–Alpert ionization gauge is systematically examined and theoretically treated. The effective pumping speed is so modified as to include the effect of back diffusion of oil vapour from the diffusion pump and the contribution of ionization pumping. The theory is experimentally verified in some respects to deduce a new criterion for the maximum attainable vacuum with the diffusion pump. Oil and mercury diffusion pumps are compared to deduce the superiority of mercury pump for obtaining "ultra-high" vacuum. The best vacuum (in normal working conditions) is $10^{-9} \sim 10^{-8}$ mm Hg with oil and 10^{-11} mm Hg with mercury.

533.5 : 621.317.39

2189 PRINCIPLE OF A SEMICONDUCTOR MANOMETER IN THE PRESSURE RANGE OF 1 TO 10^{-4} mm Hg. M.Varićak and B.Saftić.
Rev. sci. Instrum., Vol. 30, No. 10, 891-5 (Oct., 1959).

Experiments investigating the use of semiconductors for low-pressure measurements proved that thermistors give the best results. These experiments led to the construction of thermistor systems consisting of miniature thermistors fixed to thin metal foils. With these systems it is possible to measure pressure changes in the range of 1 to 10^{-4} mm Hg. The problem of temperature compensation is discussed and it is shown that in the case of thermistors this problem may be resolved by means of the voltage v. current characteristics. A detailed description of the apparatus, including the gauge head as well as the electric circuit and the calibration curves, is given.

533 5 : 621.317.79

2190 SMALL LIGHTWEIGHT IONIZATION GAUGE CONTROL CIRCUIT. H.B.Benton.
Rev. sci. Instrum., Vol.30, No.10, 887-8 (Oct., 1959).

A lightweight, compact thermionic ionization gauge control is described which is simpler and more efficient than conventional units Emission regulation is achieved by using a transistorized feedback amplifier to maintain constant emission current in the presence of variations in supply voltage and pressure. Ion current is measured from 10^{-9} to 10^{-4} A, in a single range, using a Zener diode as a logarithmic element in the collector circuit.

533.5 : 537.534

2191 MASS SPECTROMETER LEAK DETECTOR WITH IMPROVED SENSITIVITY. J.L.Peters.
Rec. sci. Instrum., Vol. 30, No. 12, 1093-5 (Dec., 1959).

A new type of mass spectrometer leak detector is described which has a sensitivity for helium of 10^{-13} standard cm^3/sec with a signal-to-noise ratio of unity. Operating pressure is in the 10^{-5} to 10^{-9} mm Hg range, time for 2/3 rds of final response is 2 sec or less, and operating characteristics are similar to present helium-sensitive mass spectrometer leak detectors.

533.5

2192 METHOD FOR RAPID DETERMINATION OF VACUUM OUTGASSING RATES. I.P.S.Fish.
Rev. sci. Instrum., Vol. 30, No. 10, 889-90.(Oct., 1959).

A method for the rapid determination of vacuum outgassing rates is described. Automatic range selection and automatic recording is used to accomplish this. Outgassing rates from 10-3 to 10-7 torr litre/sec can be determined.

VIBRATIONS · ACOUSTICS

534.13

2193 VIBRATIONS OF THICK CYLINDRICAL SHELLS. J.E.Greenspon.
J. Acoust. Soc. Amer., Vol.31, No.12, 1682-3 (Dec., 1959).

The author compares his results, previously published (Office of Naval Research Project No. 385-412, Tech. Rept., No.1, Feb., 1959), with those of Gazis (Abstr. 6641-2 of 1959) concerning flexural harmonic wave propagation in infinitely long hollow circular cylinder. In particular, he has found that the general solution contains non-dispersive torsional modes, which were not present in Gazis's solution. J.K.Skwirzynski

534.13

2194 SOLID CONE IN LOGITUDINAL HALF-WAVE RESONANCE. D.Ensminger.
J. Acoust. Soc. Amer., Vol.32, No.2, 194-6 (Feb., 1960).

Formula were derived for determining particle velocity, particle velocity amplification, stresses, length, and mechanical impedance of sections of solid cones--lateral dimensions small compared with the wavelength--in longitudinal half-wave resonance. Unlike the velocity amplification factor of the exponentially tapered bar, that of the conical section does not approach infinity but approaches a limit as the ratio of end diamters approaches infinity. A sample calculation shows the maximum velocity amplification possible from a conical section of steel half-wave resonant at 20 kc/s to be approximately 4.61 as compared with Merkulov's calculated limit of approximately 4.6.

534.2

2195 GUIDED WAVES IN A FLUID WITH CONTINUOUSLY VARIABLE VELOCITY OVERLYING AN ELASTIC SOLID: THEORY AND EXPERIMENT. I.Tolstoy.
J.Acoust. Soc. Amer., Vol. 32, No. 1, 81-7 (Jan., 1960).

Satisfactory agreement between theory and experiment has been secured for the propagation of very low frequency sound (10 and 20 c/s) emitted by a point source in a thick sedimentary layer (607 m) overlying a solid elastic basement. In the theory the sediment is treated as a fluid of sound velocity varying with the depth z like $(pz + a)^{-1/2}$, and the basement is represented by a solid elastic half-space of Poisson's ratio $\frac{1}{4}$. The wave equation has been integrated numerically on an electronic computer. The physical theory, and, in particular, the interesting coupling effects between sound waves and Stoneley or interface waves are discussed. The experimental procedure was the same as the one used in a previously published account of experiments (Abstr. 8652 of 1958) in a different frequency range. Theoretical predictions of the behaviour of the sound field in range of 1 to 5 km are in substantial agreement with the measurements.

534.2

2196 STUDY OF ACOUSTIC PROPAGATION IN A TWO-LAYERED MODEL.
R.K.Eby, A.O.Williams, Jr, R.P.Ryan and P.Tamarkin.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 88-99 (Jan., 1960).

To study acoustic propagation in shallow water without the idealization of conventional theory or the many unknowns in field trials, a model with known realistic parameters is used. A water layer 0.5 to 2 cm deep overlies a 2 in slab of Hycar rubber with greater density and sound speed. With frequencies from 55 to 600 kc/s, a small probe in the water allows measurements of phase and group velocities, vertical pressure distributions, mode interferences, and attenuation coefficients. Theoretical predictions about the effects of compressional absorption and shear waves in the bottom, and of sloping bottoms, are supported. An analysis of the additional attenuation caused by rough surfaces is made by spreading small metal spheres on the bottom. This attenuation is proportional to area density of the spheres, the free-field scattering cross section of a sphere, and the acoustic intensity at the depth of the spheres. An additional factor is the fraction g of scattered power actually lost; g correlates empirically with the ratios water depth to sphere radius and sphere radius to acoustic wavelength. A phenomenological theory ties these results together.

534.2 : 538.56

THE EXACTNESS OF THE SOLUTION OF A PROBLEM OF DIFFRACTION OR OF PROPAGATION. See Abstr. 1204

534.2

2197 ON SOME NON-LINEAR EFFECTS IN SOUND-FIELDS, WITH SPECIAL EMPHASIS ON THE GENERATION OF VORTICITY AND THE FORMATION OF STREAMING PATTERNS. S.Tjøtta.
Arch. Math. Naturvid., Vol. 55, No. 1-2, 68 pp. (1959).

Two related papers dealing with the same subject. Pt I deals with general theory and Pt II with the particular case of streaming caused by a sound-beam. The effects discussed can be observed in the noise field from a jet aircraft, the distribution of energy in the sound-spectrum varying with range. In Pt I, the following theoretical aspects are considered: (1) equations of motion in a viscous homogeneous fluid for finite amplitude waves, and (2) the vorticity equation. The paper concludes with a discussion of the general theory of acoustic streaming. In Pt II the streaming effect caused by a sound beam, better known as the "quartz wind" or "sonic wind" effect, is associated with the mechanism of radiation pressure. In the theoretical treatment of this phenomena the divergence of the sound beam and the variation of intensity across the beam have been taken into account. In particular the collimated sound beam in a cylindrical tube is discussed. A.B.Wood

534.21

2198 ACOUSTIC RESEARCH AT BOUNDARY BETWEEN SOLID AND LIQUID BODIES. R.Krause.
Z. angew. Phys., Vol. 11, No. 4, 149-55 (April, 1959). In German.

The transmission of an acoustic wave through a solid body immersed in a liquid for any given angle of incidence is examined theoretically on the assumption that the damping is negligible and that the solid has a perfectly smooth surface. Experimental observations using an impulse technique are described using Al and hard rubber plates in water and the results show close agreement with the theory. The transmission through a solid having a rough surface on one side is then considered and the energy losses in the thin surface layer are plotted as a function of the depth of the asperities. Absorption of up to 95% of the incident energy can be obtained for surface asperities of the order of the wavelength of the incident beam. H.J.H.Starks

534.22

2199 MEASUREMENT OF VELOCITY OF SOUND FROM RESONANCE IN OPEN PIPES. D.S.Ainslie.
Amer. J. Phys., Vol. 28, No. 2, 167 (Feb., 1960).

Describes a demonstration experiment for the measurement of the velocity of sound in air using an open Pyrex glass tube with a small cone speaker connected to an audio-oscillator, and a hearing-aid microphone connected to a cathode-ray oscilloscope.

534.22

2200 FACTORS AFFECTING COMPRESSIONAL WAVE VELOCITY IN UNCONSOLIDATED MARINE SAND SEDIMENTS. H.Brandt.

J. Acoust. Soc. Amer., Vol. 32, No. 2, 171-9 (Feb., 1960).

The influence of porosity, gas content, pressure, and temperature on the compressional wave velocity in unconsolidated marine sand sediments is presented. Velocity behaviour is explained from theory. The theoretical behaviour is compared with velocity data obtained for sediments in situ, and velocity data obtained in the laboratory. The significant conclusions reached in this study are (1) sediment porosity is the most important factor affecting velocity in unconsolidated water-saturated sand sediments; (2) velocity in a shallow unconsolidated water-saturated sand sediment is nearly independent of the depth of the water above the sediment (within 1% down to a depth of 1000 ft); (3) velocity in an unconsolidated sand sediment is proportional to the velocity in the sea water saturating the sediment; (4) velocity in an unconsolidated water-saturated sand sediment increases with an increase in temperature; and (5) velocity in an unconsolidated sand sediment saturated with a mixture of gas and water is considerably lower than the velocity in a sediment saturated with water.

534.22

2201 ULTRASONIC VELOCITIES IN ROCKS: SOME SPECIAL FEATURES OF INDIAN GRANITES. S.Balakrishna.

Proc. Indian. Acad. Sci. A, Vol. 48, No. 2, 69-75 (Aug., 1958).

It is now established that the sound velocity in most Indian granites is of the order of 6.2 km/sec. This relatively high velocity, when compared to granites from other countries at atmospheric conditions of pressure and temperature, indicates more compactness due probably to older age. Transmission of sound also depends mainly upon the granular texture. A plot of longitudinal velocity in rocks versus hydrostatic pressure on the sample shows that the velocity increases rapidly with pressure at lower values and then slowly with pressure in the higher ranges.

534.22

2202 SHOCK WAVES. M.J.Lighthill.

Mem. Manchester Lit. Phil. Soc. Vol. 101, 7-22 (1958-59).

Ramsden Memorial Lecture. Review (for the non-specialists) of shock wave phenomena in gases, liquids and solids, and in interstellar matter. Analogous phenomena, such as deceleration waves in traffic flow and river flood waves (bores), are considered.

534.22 : 538.3

2203 SOME REMARKS ON THE STRUCTURE OF SHOCK WAVES. G.S.Golitsyn and K.P.Stanyukovich.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 828-30 (Sept., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 3, 575-6 (March, 1959).

It is shown that at a maximum of the entropy in a shock wave the fluid velocity relative to the shock equals the local speed of sound. This result is stated to be true also for hydromagnetic and for relativistic shocks and (at two places) for detonation fronts. Simple methods of estimation are used to show that for strong magnetic fields the shock thickness is decreased by an increase of conductivity or of magnetic field. O.Penrose

534.22 : 541.12

CALCULATION OF REACTION PROFILES BEHIND STEADY STATE SHOCK WAVES. See Abstr. 1957

534.22

2204 A SIMILARITY SOLUTION FOR A [SPHERICAL] BLAST IN FREE SPACE. S.F.Borg.

J. Franklin Inst., Vol. 268, No. 6, 446-52 (Dec., 1959).

The solution satisfies the equations of gas dynamics: (a) conservation of mass; (b) conservation of momentum; (c) conservation of energy. In addition, the usual gas laws are assumed to apply. A solution is obtained which applies exactly to the case of a contained explosion, i.e. an explosion such that along the boundary of the sphere (exploding region) an equalizing pressure is at all times maintained which is just equal to the boundary pressure. This condition is one which, physically, can occur if the containment could, for example, be maintained by means of a magnetic or similar field external to the bulk of the gas. It is shown that the solution may also be approximately valid without a containing boundary pressure but with a rim (or boundary) shock wave satisfying the ideal gas Rankine-Hugoniot shock conditions, although this is speculative.

534.23

2205 SOUND FIELD OF A RECTANGULAR PISTON. A.Freedman.

J. Acoust. Soc. Amer., Vol. 32, No. 2, 197-209 (Feb., 1960).

The amplitude and phase of the pressure in the field of a rectangular piston, assumed vibrating within an infinite, rigid baffle, are examined theoretically for ranges down to the order of the piston length. Various laws of behaviour of this field, both on and away from the acoustic axis, are deduced. An indication is given of the errors introduced by the approximations used. Such experimental evidence as is available supports the theory. Simple means are provided for constructing curves of axial pressure amplitude and phase for any ratio of length and breadth of the radiating surface, and a method is suggested for predicting the long-range axial pressure of a rectangular piston from measurements taken well within the latter's Fresnel region. The near fields of a rectangular and a circular piston are compared. That of the rectangular piston produces the more useful approximation to a plane wave.

534.23 : 539.2

2206 AN ULTRASONIC ATTENUATION UNIT AND ITS USE IN MEASURING ATTENUATION IN ALKALI HALIDES. B.Chick, G.Anderson and R.Truell.

J. Acoust. Soc. Amer., Vol. 32, No. 2, 186-93 (Feb., 1960).

An instrument for measurement of ultrasonic attenuation and velocity in the frequency range from 5-200 Mc/s is described. The unit incorporated a pulsed r.f. oscillator, superheterodyne receiver, exponential wave-form generator, precision time delay generator (useful in velocity measurements), c.r.t. display circuits, and appropriate synchronization circuits. Ultrasonic attenuation measurements made in single crystals of NaCl and KCl during deformation and recovery at several temperatures are reported here.

534.24

2207 REFLECTION OF SOUND FROM COASTAL BOTTOMS. K.V.Mackenzie.

J. Acoust. Soc. Amer., Vol. 32, No. 1, 221-31 (Feb., 1960).

The theory is discussed for the reflection of sound from flat and uniform fluid bottoms. Experimental 1 kc/s data obtained over three typical bottoms are presented for a range of grazing angles of incidence from 12° to 90°. Experimental data are presented for normal incidence over several bottoms at frequencies of 4, 7.5, and 16 kc/s. The experimental data are compared with the available theories and the conclusion is reached that the Rayleigh theory modified by assuming a complex velocity for the bottom gives the best agreement and that the agreement is best when the bottom attenuation is assumed to vary as the first or higher power of the frequency.

534.26 : 538.56

2208 TRANSIENT DIFFRACTION OF SCALAR WAVES BY A FIXED SPHERE. R.G.Barakat

J. Acoust. Soc. Amer., Vol. 32, No. 1, 61-6 (Jan., 1960).

Diffraction from a fixed sphere is treated as an initial value problem rather than as a boundary value problem. By requiring only boundedness of the diffracted wave potential rather than the stronger Sommerfeld radiation condition, it is shown via use of the Laplace transform and complete inversion integral that the diffracted wave potential consists of the usual steady state term plus transient terms. The magnitude of the transient terms are governed by $\beta = ka$ where a is the radius of the sphere and k is the wave number; however, the rate of decay is governed by the dimensionless decay parameter ωt. Both Dirichlet and Neumann boundary conditions are discussed in detail. Finally, the transient force on the sphere is computed in the Neumann case and the behaviour examined for the long-wave ($\beta \ll 1$) and short-wave ($\beta \gg 1$) approximates.

534.26 : 538.56

DIFFRACTION BY AN INFINITE SLIT. See Abstr. 1207

534.26

2209 MEASUREMENTS OF THE BACKSCATTERING OF UNDERWATER SOUND FROM THE SEA SURFACE. G.R.Garrison, S.R.Murphy and D.S.Potter.

J. Acoust. Soc. Amer., Vol. 32, No. 1, 104-11 (Jan., 1960).

Measurements of the backscattering of 60 kc/s sound from the

surface of the sea have been made in Puget Sound in an effort to relate the strength of the scattered sound to the character of the surface. In addition providing a means of predicting reverberation levels, an attempt has been made to obtain a better understanding of the fundamental mechanism of scattering at the air–water boundary. The reverberation measurements are presented, along with observations of several oceanographic and meteorological parameters. An examination of the data allows the following conclusions: (1) reverberation pulses from an area of several square yards follow a Rayleigh distribution; (2) reverberation cannot be directly related to the wave height, but is closely correlated with wind speed; (3) reverberation increases with wind speed to a speed of 14 knots, and remains constant for higher wind speeds; and (4) reverberation is independent of the angle with the surface for angles from 20° to 60°, but drops off rapidly as the angle is decreased below 20°.

534.26

2210 THE SCATTERING OF A PLANE WAVE BY A ROW OF SMALL CYLINDERS. R.F.Millar.

Canad. J. Phys., Vol.38, No.2, 272-89 (Feb., 1960).

Consideration is given to the scattering of a plane wave by N cylinders equispaced in a row. The problems associated with scatterers, both "soft" and "hard" in the acoustical sense, are treated. An application of Green's theorem together with the appropriate boundary condition on the cylinders leads to a set of simultaneous integral equations in the unknown function on the cylinders. Solutions in the form of series in powers of a small parameter δ (essentially the ratio of cylinder dimension to wavelength) are assumed. In the case of elliptic cylinders, the integral equations are reduced to sets of linear algebraic equations. Only for the first term in the solution for "soft" cylinders is it necessary to solve N simultaneous equations in N unknowns; all other equations involve essentially only one unknown. Far-fields and scattering cross-sections are calculated. The case of two "soft" cylinders is given particular attention. Conditions for justification of the neglect of higher-order terms are discussed. It is found that all terms but the first (in either problem) may be neglected if $\delta \ll 1$ and $(N-1)/(ka)$ is sufficiently small. (Here a is the spacing between centres of adjacent cylinders, and k is the wave number.) For this reason these solutions are most useful when the number of cylinders is small.

534.26

2211 SCATTERING OF A PLANE LONGITUDINAL WAVE BY A SPHERICAL FLUID OBSTACLE IN AN ELASTIC MEDIUM. N.C.Einspruch and R.Truell.

J. Acoust. Soc. Amer., Vol. 32, No. 2, 214-20 (Feb., 1960).

The method of Ying and Truell (1954) for studying the scattering of longitudinal elastic waves by spherical obstacles is applied to the particular case of scattering by a fluid-filled cavity that is embedded in an isotropic elastic solid. Exact solutions for the expansion coefficients which describe the scattered elastic wave are obtained. The limiting case of $ka \ll 1$ (Rayleigh scattering) is considered in detail. A general expression for the scattering cross-section is derived.

534.6

2212 ACOUSTIC RADIATION FORCE ON A UNIFORMLY MOVING SMOOTH BODY, TO THE FIRST ORDER IN THE VELOCITY. J.Lothe.

J. Acoust. Soc. Amer., Vol. 32, No. 1, 140-1 (Jan., 1960).

It is shown that the acoustic radiation force on a uniformly moving smooth body is given correctly to the third order by simple first-order theory, in agreement with a calculation by Nabarro. (Abstr. 1683 of 1951).

534.61

2213 ACOUSTIC INTENSITY FLUCTUATIONS AND TEMPERATURE MICROSTRUCTURE IN THE SEA. F.H.Sagar.

J.Acoust. Soc. Amer., Vol. 32, No. 1, 112-21 (Jan., 1960)

The range dependence of variation coefficients has been investigated for each of eight selected experiments performed in New Zealand waters during midsummer for a variety of meteorological conditions. These experiments have employed 1.3 ms pulses of 14.5 k/cs sound from a projector of variable depth (40 to 100 ft). The pulses have been simultaneously received by a vertical string of six equidistant hydrophones (extreme depths 40 and 165 ft) and the square of the average variation coefficient V for the six hydrophones has been plotted against the range R to test for the eight individual experiments the applicability of the Mintzer fluctuation formula. This predicts for a medium exhibiting temperature microstructure that $V^2 \propto R \cdot f^2 \alpha^2 a$, where f is the frequency and α and a are the r.m.s.values of the refractive index and the correlation length of fluctuation in the refractive index respectively. An area was selected where the sea is fed by no rivers of any size, the depth varying with experiment from 40 to 200 fathoms. Drought conditions prevailed over the whole period of the work, and, as far is known, no confluence of local ocean currents here produces microstructure. The latter if present should presumably be confined to surface layers and be due to diurnal insolation. One has hence selected for analysis those experiments performed during small swell and sea state in: (a) the early morning, (b) hot sunshine during the mid and late afternoons, (c) the mid-afternoon during cool days with a completely covered sky, and (d) early evening after hot cloudless days. Close correlation exists between insolation and intensity fluctuations which follow the Mintzer dependence on range and the values of $\alpha^2 a$ obtained $[(5.0-11.0) \times 10^{-7}]$ are near the mean value reported by Sheehy (5.0×10^{-7}), [Abstr.2981 of 1950]. The fact that the Mintzer formula is obeyed by case (b) only and the small values of V and independence of V upon R for the aforementioned conditions (a), (c) and (d) are interpreted to mean a diurnal cycle of growth and decay of insolation–produced microstructure in the surface layers of the sea in summer.

534.81

2214 NEW CONSIDERATIONS ON THE FUNCTIONING OF AN ORGAN PIPE. J.Mercier.

Ann. Telecomm., Vol. 14, No. 11-12, 297-300 (Nov.-Dec., 1959). In French.

A theoretical treatment of the behaviour of a closed organ pipe in forced oscillation at resonance. The study is concerned with the stationary waves inside the pipe and the progressive waves external to the pipe. Particular consideration is given to the transition zone at the open end of the pipe. The paper concludes with a discussion of the end correction to the length of the pipe. A.B.Wood

534.81 : 621.395.6

2215 THE USE OF THE "SONOGRAPH" IN THE DETERMINATION OF THE QUALITY OF STRINGED INSTRUMENTS. E.Leipp and A.A.Moles.

Ann. Telecomm., Vol. 14, No. 5-6, 135-42 (May-June, 1959). In French.

The characterization and appreciation of musical instruments depends on a comparison of the subjective aspects of the sound perceived by the ear and the objective elements of the sound phenomenon produced by the instrument. The "sonograph" or acoustic spectrometer, gives a direct representation of the form of the "sound object" furnished by the instrument. The paper describes an investigation of the sound emitted by violins under varied conditions of excitation (bowing, string tension etc.) and damping. A.B.Wood

534.83

2216 NOISE PRODUCTION IN A TURBULENT BOUNDARY LAYER BY SMOOTH AND ROUGH SURFACES. E.J.Skudrzyk and G.P.Haddle.

J. Acoust. Soc. Amer., Vol. 32, No. 1, 19-34 (Jan., 1960).

In a turbulent boundary layer, the effective velocity fluctuations amount to about 4% of the free-stream velocity, independent of the curvature of the body and within wide limits independent of the velocity of the flow. The fluctuations in pressure can then be computed from those of the velocity by an equation similar to the standard Bernoulli equation, except that the numerical constant is different. Vortices pass along the receiving hydrophone; they represent pressure pulses that generate a constant power spectrum at low frequencies that decreases approximately inversely proportional to the cube of the frequency at higher frequencies. This information, in conjunction with the pressure equation, makes it possible to compute the power spectrum of the flow noise as a function of the frequency, the boundary-layer thickness and the speed of the flow. The flow noise at greater speeds and at higher frequencies turns out to be predominantly generated by the surface roughnesses. A small hydrophone records the local fluctuations at the pressure in the boundary layer; on the other hand, a large hydrophone is very insensitive to the small-scale turbulence. It indicates the true sound pressure that is produced by the generation and the decay of the turbulence and by the vibrations of the walls of the vessel. A large hydrophone therefore reads the same pressure, whether it is placed inside the boundary layer or outside the near field region, not too far away from the turbulent layer. The theoretical conclusions are borne out, qualitatively and quantitatively,

by the experimental results obtained with the aid of a rotating cylinder and through measurements in the test section of the Garfield Thomas Water Tunnel.

534.83

2217 NOISE SURVEYS OF COCKTAIL PARTIES. R.F.Legget and T.D.Northwood.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 16-18 (Jan., 1960).

Discusses and enlarges on a recent theoretical paper by MacLean (Abstr. 6665 of 1959) on the acoustics of cocktail parties. The discussion is supported by experimental evidence accumulated during the past two years. MacLean's analysis suggests that there is a critical density of participants above which a "quiet" cocktail party becomes abruptly "noisy". It would appear that one might actually plan a quiet or noisy party as required (assuming control over the number of participants). Unfortunately the cases studied experimentally do not show this quiet–noisy transition, and it is believed that factors not considered in the theory result in a blurring of the distinction. Indications are that there is a gradual increase in sound level to a saturation value that is independent of the properties of the room, the beverages served, and the number of participants. There is, however, dependence on the sex of the participants.

534.84

2218 ON NAMING REVERBERATION EQUATIONS. R.W.Young.
J. Acoust. Soc. Amer., Vol. 31, No. 12, 1681 (Dec., 1959).

Names are proposed for the four equations met in engineering practice: (1) approximate Sabine (reverberation) equation, (2) Sabine (reverberation) equation, (3) arithmetric reverberation equation, and (4) geometric reverberation equation. H.D.Parbrook

534.84 : 621.395.6

2219 MEASUREMENT OF THE ACOUSTIC CHARACTERISTICS OF A "DEAF" (DEAD, ANECHOIC) ROOM. B.Karafakioglu.
Ann. Telecomm., Vol. 14, No. 5-6, 129-34 (May-June, 1959). In French.

After outlining the requirements which should be fulfilled in the acoustics of an anechoic (sourde) room, a description is given of the construction of such a room at the technical University of Istanbul and the measurements which have been made to verify the distribution of the acoustic field in it. A determination has also been made, by a new method, of the time of reverberation at different frequencies in the range 125 to 4000 c/s. A. B. Wood

534.84 : 621.395.6

2220 EXPERIMENTS IN THE MEASUREMENT OF [SOUND] INSULATION [OF WALLS] IN SITU. A.C.Raes.
Ann. Telecomm., Vol. 14, No. 9-10, 210-17 (Sept.-Oct., 1959). In French.

Results are given of a large number of measurements which have been made in various buildings to determine the acoustic insulating quality of the walls and partitions. After describing the method of measurement employed, results are compared with those obtained by "classic" laboratory methods. It is indicated how the "in situ" method reveals faults in construction, and its importance in estimating the acoustic qualities of buildings is emphasized. A.B.Wood

534.84

2221 ACOUSTICAL DESIGN AND PERFORMANCE OF THE STRATFORD (ONTARIO) FESTIVAL THEATRE. R.H.Tanner.
J. Acoust. Soc. Amer., Vol. 32, No. 2, 232-4 (Feb., 1960).

The Stratford (Ontario) Shakespearean Festival has had a record of continuing success since it was started six years ago in a unique theatre tent. Since then, the festival authorities have built a new permanent theatre retaining the unusual stage and general seating arrangements which combined the Greek and Elizabethan architectural traditions. The shape of the theatre and, in particular, the use of a semicircular rear wall centred in the middle of the acting area, presented certain obvious acoustical problems. This paper describes the means taken to overcome this difficulty together with the results obtained.

534.86 : 621.395.625.3

2222 EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE MAGNETIC PROPERTIES OF IRON OXIDE RECORDING TAPE. E.D.Daniel and I.Levine.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 1-15 (Jan., 1960).

The results of remanent magnetization tests made under ordinary and anhysteretic conditions are given, and it is shown that the major anhysteretic properties of a recording tape can be expressed in terms of three easily measured constants. The design of the test equipment is discussed and test results are listed for thirteen representative types of tape. Some of the theories of fine particle magnets that can be applied to recording tape are reviewed and an extensive treatment of remanent magnetization based upon the Preisach diagram is given. Some aspects of the Preisach diagram treatment may be of interest to workers outside the magnetic recording field. The anhysteretic properties are important in h.f. biased recording.

OPTICS . PHOTOMETRY

535.24

2223 A FILTER PHOTOMETER FOR REFLECTION MEASUREMENTS. H.J.Höfert.
Z. InstrumKde, Vol. 67, No. 5, 118-24 (May, 1959). In German.

Two specimens to be compared are mounted in the surface of an integrating sphere and illuminated indirectly by filament lamps, or, for fluorescent specimens, by a xenon lamp. Normally reflected light from the specimens is received respectively by 2 photocells connected in a null circuit to an amplifier. A photometric aperture is in front of one beam. "Monochromatic" or trichromatic (C.I.E.) filters are provided. Sources of error are discussed; precision of 0.1% is claimed. The instrument is made by Carl Zeiss. G.F.Lothian

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

535.3

2224 CONSIDERATIONS ON THE THEORY OF REFLECTION BY A MIRROR ROTATING WITH CONSTANT ANGULAR VELOCITY. J.Picht.
Z. Phys., Vol.156, No.3, 468-87 (1959). In German.

Earlier treatments have shown that a plane mirror rotating with constant angular velocity behaves like a concave cylindrical mirror. The effective focal length is found by the author to be twice the value given by Lorentz. The result of the present relativistic treatment agrees with this conclusion. T.R.Carson

535.31

2225 ON THE SAMPLING THEOREM OF THE SECOND KIND. H.Wolter.
Arch. Elekt. Übertragung, Vol. 13, No. 11, 477-81 (Nov., 1959). In German.

According to the theorem as usually stated only a finite amount of information about an object can be gained by measurements over a finite extension of the image in coherent illumination. It is shown that on the contrary by a sufficiently large number of observations on this limited image an indefinitely close approximation to the object can be obtained. The precision is limited only by random apparatus errors and quantum effects, not by the aperture and field of the optical system. W.T.Welford

535.31

2226 GAUSSIAN OPTICS OF A "QUASI-CENTRED" SYSTEM. F.Scandone and L.Ballerini.
Atti Fond. Ronchi, Vol. 14, No. 5, 513-23 (Sept.-Oct., 1959). In Italian.

The type of system is considered which strictly does not possess an axis of symmetry but in which deviations from an ideal system of revolution are small. The formulae governing image formation are developed and these show which properties of a

centred system are maintained in a quasi-centred system and which properties are modified. The use of these formulae in photogrammetry is briefly indicated. R.W.Fish

535.31

2227 GAUSSIAN OPTICS OF SYSTEMS WITH VARIABLE FOCAL LENGTH. C.Morais.
Atti Fond. Ronchi, Vol. 14, No. 6, 635-51 (Nov.-Dec., 1959). In Italian.

Deals with a method for the computation of all the parameters which characterize an optical system with variable focal length; all possible solutions are taken into account. By introducing the condition $\Sigma 1/f_i = 0$, where f_i represents the focal length of the i-th lens, the conditions required for obtaining lenses which provide a plane field without astigmatism are indicated. Some numerical examples are given.

535.31

2228 PARAXIAL PROPERTIES OF A SYSTEM FORMED OF TWO CROSSED PLANO-CYLINDRICAL LENSES. C.Morais.
Atti Fond. Ronchi, Vol. 14, No. 5, 525-34 (Sept.-Oct., 1959). In Italian.

The system consists of two plano-cylindrical lenses with their plano surfaces facing each other. The angle between the axes of the two cylinders is taken as a variable. The image formation is calculated and the results are applied to typical practical systems. R.W.Fish

535.32

2229 REFRACTIVE INDICES OF FUSED QUARTZ AND LITHIUM FLUORIDE. T.L.Van Raalte.
J. Opt. Soc. Amer., Vol. 50, No. 1, 85 (Jan., 1960).

Published values show an anomaly at 2749 A; improved interpolated values are suggested. G.F.Lothian

535.32

2230 MEASUREMENT OF THE REFRACTIVE INDEX OF SILICONE OILS FOR THE U.K.A.E.A. T.L.Van Raalte.
J. Opt. Soc. Amer., Vol. 50, No. 1, 85-6 (Jan., 1960).

Values of n_D, n_C-n_F and reciprocal dispersive power (V_D), and their temperature coefficients are determined for 6 oils. Temperature coefficients are not so low as was hoped, but the oils lie in an "unoccupied" region of the n_D, V_D diagram and may be useful for lenses. G.F.Lothian

535.33

2231 A NOMOGRAM FOR DETERMINATION OF THE PARAMETERS OF THE EMISSION-LINE PROFILES WITH SELF-ABSORPTION. É.V.Kononovich.
Astron. Zh., Vol. 36, No. 2, 371-4 (1959). In Russian.

The principle of a nomogram for determination of the profile of an emission line, originating in an optically thick layer, is given. A particular case of such a nomogram is constructed, assuming that the absorption coefficient is determined by the Doppler effect. A.Tybulewicz

535.8

2232 AXICONS AND THEIR USES. J.H.McLeod.
J. Opt. Soc. Amer., Vol. 50, No. 2, 166-9 (Feb., 1960).

The most common axicon is a flat cone. A small source of light on the axis of the cone is imaged into a line along a portion of the axis. In lenses the spot diagram has been useful in evaluating image quality. In axicons a corresponding line diagram where lines take the place of dots is useful. In general, axicon instruments correspond to the usual optical instruments. For example, an axicon may be used as an objective to form a telescope. The resulting axicon telescope may be used in aligning machinery such as paper mills. Similarly, an axicon autocollimator may be used to precisely set mirrors perpendicular to a line. One form of axicon microscope has been tried out for the special purpose of locating the position of shiny surfaces without touching them. A most useful form of optical aligner is the reflection cone axicon. It is used as a straight edge. One example is a reflecting cone of 6 in. diam and maximum range of 40 ft with precision of 5 or 6 wavelengths over the entire range. Another example is a 5 in. diam cone with a range of 10 ft and precisions of about 1 wavelength. In this case the use of a suitable radius for the reflecting surface had the effect of making the image brightness substantially uniform over the 10 ft range. Photo cell pickup has been shown to be successful with very high precisions of setting. This opens the way for automatic machine guiding to very high precisions.

535.8

2233 CONSIDERATIONS REGARDING THE POSSIBLE USE OF SOME OPTICAL ELEMENTS. N.Bárány.
Periodica polytech., Elect. Engng, Vol. 3, No. 3, 183-96 (1959).

Some precision mechanical adjusting devices for use with optical instruments are described. These include a lever-controlled interocular distance adjuster and a push-button colour filter changer.

535.8

2234 NOVEL SYSTEM FOR OBTAINING VARIABLE PHASE CONTRAST. J.R.Meyer-Arendt.
J. Opt. Soc. Amer., Vol. 50, No. 2, 163-5 (Feb., 1960).

The variable phase system described is characterized by a wide separation of the deviated and the undeviated light bundles so that phase-modifying or absorbing elements can readily be inserted. The path separation is accomplished by a partially aluminized plate inserted in a direction normal to the optical axis, thus facilitating the necessary alignment. Geometrical coincidence has been obtained by introducing into one of the pathways a penta-type mirror system.

535.8

2235 HIGH-SPEED TURBINE-DRIVEN ROTATING MIRRORS: NOTES ON DESIGN, CONSTRUCTION, AND PERFORMANCE. B.Brixner.
Rev. sci. Instrum., Vol. 30, No. 11, 1041-8 (Nov., 1959).

Described in detail are the main features of design and fabrication which contribute to the production of the reliable long-lived drives of several styles of high-speed turbine-driven rotating mirrors. The subjects analysed are steel mirror fabrication, which includes heat treatment; mirror balancing and surface finishing techniques; important bearing design features; construction of the turbine; and performance of selected models.

535.8

2236 CADMIUM SULFIDE INFRARED OPTICAL MATERIAL A.B.Francis and A.I Carlson.
J Opt. Soc. Amer., Vol. 50, No. 2, 118-21 (Feb., 1960).

Cadmium sulphide is investigated as an i.r. optical material. Properties of the crystal presented include index of refraction, percent transmission, hardness, coefficient of thermal expansion, solubility, workability. CdS is also compared with other common i.r. materials.

535.8

2237 A NEW HIGH-REFRACTIVE-INDEX MATERIAL FOR DIELECTRIC ULTRAVIOLET MIRRORS. G.Honcia and K.Krebs.
Z. Phys., Vol.156, No.2, 117-24 (1959). In German.

For use as the high index material for dielectric multilayers for ultraviolet interferometers in the region λ3200-λ2400 A, PbF_2 is found suitable. The layers are not affected by damp air and test shows that they survived unchanged for 12 weeks when left exposed. Refractive index data are given between λ5000 (μ~1.75) and λ2300 (μ~2.45) for various film thickness. Absorption coefficients are given. Reflecting and transmission data for 9 and 11 multilayers (with cryolite) are recorded. S.Tolansky

535.8 : 539.1.07

STEREOSCOPY IN BUBBLE CHAMBERS. REFRACTION CORRECTION. See Abstr. 1232

535.8 : 539.16

2238 LIGHT SOURCES USING RADIOISOTOPES. E.J.Wilson and J.D.H.Hughes.
Contemporary Physics, Vol. 1, No. 1, 62-9 (Oct., 1959).

The use of radioisotopes in conjunction with phosphors to produce practical sources of light is described. These sources are completely self-contained, require no maintenance, and provide useful light for several years. For instance, a one-curie krypton source fitted with an eight-inch lens is visible at 1000 yards in darkness, and will fall to half-strength in 3-5 years. Markers of less than one millicurie are easily visible at several feet.

535.33

2239 TIME-LAPSE EMISSION SPECTRA USING A ROTATING SLOTTED DISC AND STATIONARY EMULSION.

W.L.Dutton and R.C.Hirt.

Appl. Spectrosc., Vol. 13, No. 5, 120-2 (1959).

The construction, use, and advantages of a slowly rotating slotted disk at the slit of a stigmatic spectrograph are described and illustrated in the production of time-lapse spectograms.

535.33

2240 A NEW INFRARED SPECROMETER IN THE 12.5-25 MICRON REGION.

N.L.Alpert, F.Behnke and P.A.Strauss.

Appl. Spectrosc., Vol. 13, No. 5, 130-2 (1959).

In order to extend its wavelength region to 25μ a Perkin–Elmer Infracord has been adapted for use with a KBr prism. Design of the instrument and its performance characteristics are described. Experiments have been performed to illustrate several classes of chemical problems for which the 12.5 to 25μ region of the spectrum is particularly useful in solving. Typical spectra are shown.

535.33

2241 ENERGY-LIMITED RESOLUTION OF SPECTROMETERS FOR THE MIDDLE AND FAR INFRARED.

L.Beckmann, E.Funck and R.Mecke.

Z. angew. Phys., Vol. 11,No. 6, 207-11 (June, 1959).

Expressions are obtained for: (1) the dimensions of monochromator which just fills a detector of given size - the exit slit being imaged on the detector by a beam subtending a maximum angle of 100°; (2) the smallest wave number range ($\Delta\nu_{min}$) which gives adequate signal/noise ratio; (3) the largest wave number range ($\Delta\nu_{max}$) which just fills the detector; (4) the longwave limit for which a fully filled detector just gives adequate response ($\Delta\nu_{max} = \Delta\nu_{min}$). Entrance and exit slits are assumed equal throughout. Data for eight published instruments show large variations in an energy factor; but a mean value is taken and used to plot numerical values of these expressions. G.F.Lothian

535.33 : 539.2

ACCURACY OF DETERMINATION OF i.r. ABSORPTION CONSTANTS WITH SINGLE AND DOUBLE BEAM INSTRUMENTS. STRAY LIGHT EFFECTS. See Abstr. 1734

535.33 : 545.8

HOLLOW CATHODE DISCHARGE TUBE FOR SPECTROCHEMICAL ANALYSIS OF ZrO_2. See Abstr. 1971

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

535.41

2242 GENERALIZED THEORY OF INTERFERENCE AND ITS APPLICATIONS. II. PARTIALLY COHERENT PENCILS.

S.Pancharatnam.

Proc. Indian Acad. Sci. A, Vol. 45, No. 6, 398-422 (Dec., 1956).

For Pt I see Abstr. 7035 (1957). The superposition of two partially coherent but completely polarized beams is discussed. The formula for the intensity of the resultant beam is obtained from the interference formula for coherent beams by multiplying the third interference term by the degree of coherence γ (defined statistically). The states of the two given polarized beams and that of the resultant incompletely polarized beam may be characterized by respective vectors drawn from the centre of the Poincaré sphere: the length of each vector and its orientation (i.e., point of intersection with the sphere) may be regarded as giving respectively the intensity and state of polarization, of the polarized fraction of the corresponding beam. The vector for the resultant beam is obtained by adding to the sum of the two given vectors (which are directed towards points A and B), a third vector directed towards a point C'' on the Poincaré sphere. This last vector which arises because of the interference of the beams, is specified in terms of the angles of the triangle ABC'' which is isosceles: the base angles A and B are both equal to the effective phase difference δ and the length of the vector is equal to $2\gamma\sqrt{I_1 I_2}\sin\frac{1}{2}\hat{C}''$. The converse problem is discussed and also the addition of n partially coherent polarized beams.

535.41

2243 GENERALISED THEORY OF INTERFERENCE AND ITS APPLICATIONS. III. INTERFERENCE FIGURES IN TRANSPARENT CRYSTALS. S.Pancharatnam.

Proc. Indian. Acad. Sci. A, Vol. 45, No. 6, 402-12 (June, 1957).

For Pt II see preceding abstract. The geometric method of specifying states of polarization by points on the Poincaré sphere is used for giving a unified and physically intelligible approach to the interference phenomena displayed by crystalline plates in parallel or convergent light—under general conditions when the polarizing and analysing states are linear, circular or elliptic in form. Examples discussed are the spiral figures exhibited in convergent light (a) by a basal section of quartz between a circular polarizer and linear analyser (or vice-versa), and (b) by two superposed basal sections of left- and right-quartz between crossed nicols. The Airy' s spirals observed in the latter case are interpreted as the "isogyres" of the optically inactive plate to which the combination is equivalent.

535.41

2244 GENERALISED THEORY OF INTERFERENCE AND ITS APPLICATIONS. IV. INTERFERENCE FIGURES IN ABSORBING BIAXIAL CRYSTALS. S.Pancharatnam.

Proc. Indian Acad. Sci. A, Vol. 46, No. 1, 1-18 (July, 1957).

For Pt III see preceding abstract. Phenomena—involving the interference of polarized light—displayed by crystalline plates (in parallel or convergent light) may be given a general method of analysis, using the physical concepts developed in Parts I and II. The subject is discussed under two main heads: the interference phenomena exhibited without and with the aid of an elliptic analyser behind the crystal plate—the former involving the interference of beams in different non-orthogonal states of elliptic polarization. The cases when the incident light is either unpolarized, partially polarized, or completely polarized are all discussed—the concept of partially coherent beams finding fruitful applications in the first two cases.

535.41

2245 A NOTE ON THE DIVERGENCE OF A SERIES FOR MULTIPLE BEAM INTERFERENCE IN A THIN METALLIC FILM. Z.Knittl.

Czech. J. Phys., Vol. 9, No. 1, 91-4 (1959).

Deals with the anomalous divergence of an infinite geometric series of complex amplitudes, pointed out by Berning (Abstr. 287 of 1957). It is shown that the paradox is of a formal mathematical nature and has no consequences for multiple beam interference as a method of derivation.

535.41

2246 MODIFICATION OF MICHELSON INTERFEROMETER USING ONLY ONE CUBE-CORNER PRISM.

M.V.R.K.Murty.

J. Opt. Soc. Amer., Vol. 50, No. 1, 83-4 (Jan., 1960).

A cube-corner and plane mirror are used in one arm and a compensating plane-parallel block and plane mirror in the other. The arrangement has the advantage of insensitivity to angular errors as in previously described cube-corner interferometers (Abstr. 4245 of 1957) but it avoids the cost of two precisely matched cube-corners. W.T.Welford

535.41

2247 LAMELLAR GRATING FAR-INFRARED INTERFEROMETER. J.Strong and G.A.Vanasse.

J. Opt. Soc. Amer., Vol. 50, No. 2, 113-18 (Feb., 1960).

The new variable-groove-depth grating-type interferometer that was used to obtain experimental interferograms and spectra used for short and long wavelengths ($\lambda < 15\ \mu$ to $\lambda > 4$ mm), together with its construction and testing, is described.

535.41

2248 INVESTIGATIONS ON OPTICAL REFLECTION INTERFERENCE FILTERS IN THE NEAR ULTRAVIOLET.

H.Porsche.

Z. angew. Phys., Vol. 11, No. 10, 382-95 (Oct., 1959). In German.

Optical constants are determined for 9 thin gold films, an iteration method of calculation being used. The apparatus employed is described. For several films the Wolter identity condition is satisfied. The Drude relation $n \approx k$ is not fulfilled in the region above 10 μ. The optical constants depend markedly on the supporting base. Identical films on glass and on arsenic sulphide exhibit marked differences. The non-continuity of the film is

discussed in relation to this. Spectral reflection curves are given for 5 reflection interference filters. Measurement and calculation agree well. Optical characteristics of the filters are explained in terms of the optical constants. S.Tolansky

535.41

2249 ON THE COLOURS OF VERY THIN PLATES. A CONTRIBUTION TO ULTRA-MICROTOMY. S.Rösch.
Z. wiss. Mikr., Vol. 64, No. 4, 236-46, (Sept., 1959). In German.

A review of the Newton colour scale in thin films viewed by reflected white light. Applicability to thin sections for electron microscopy is discussed. Colorimetric measurements are reported for a thin film with $\mu = 1.5$ between air and water. Very small thicknesses exhibit deviations from the classical Newton scale. S.Tolansky

535.42

2250 CIRCULAR AND SPIRAL DIFFRACTION GRATINGS. J.Dyson.
Proc. Roy. Soc. A, Vol. 248, 93-106 (Oct. 28, 1958).

The optical properties of gratings consisting of equally spaced concentric circles or spirals are considered and their image-forming properties are described. Expressions for the light intensity distribution in the images of a point source are derived. Examples of the use of such gratings for metrological and other purposes are indicated, together with the order of precision obtainable. The accuracy of construction of gratings for such purposes is very high, and methods for achieving this accuracy are described.

535.42

2251 THE PRESENTATION OF SPECTRAL INTENSITIES WITH A NORMAL GRATING. R.Gerharz.
Z. InstrumKde, Vol. 67, No. 2, 30-7 (Feb., 1959). In German.

A coarse grating with horizontal rulings placed between source and spectrograph slit forms on this latter 10 or more diffraction maxima of successively decreasing intensity; the number of steps visible, or the height, for a spectrum line is thus a measure of its intensity. The intensity distribution is considered theoretically and several spectrograms are shown. G.F.Lothian

535.42

2252 THE ORIGIN OF THE EFFECTS OF POLARIZATION AND OF DIFFRACTION IN OPTICAL GRATINGS.
A.Maréchal and G.W.Stroke.
C.R. Acad. Sci. (Paris), Vol. 249, No. 20, 2042-4 (Nov. 16, 1959). In French.

A brief discussion is given on how the boundary conditions imposed by the structure and nature of a metallic grating lead to a distribution of the diffracted field into the various orders. This distribution differs according to the orientation of the electric vector of the incident light wave and the difference is very marked if the grating spacing is comparable with the wavelength. The role the boundary conditions plays in the polarization effects is also investigated. Experiments with centimetre waves have verified the conclusions. H.G.Jerrard

535.42 : 534.2

2253 ON THE DIFFRACTION OF LIGHT BY PROGRESSIVE SUPERSONIC WAVES. P.Phariseau.
Proc. Indian Acad. Sci. A, Vol. 44, No. 4, 165-70 (Oct., 1956).

It has been shown that in the case of oblique incidence of the light when the angle of incidence is close to the Bragg angle and for high frequencies of the supersonic waves, the intensities of the orders 0 and −1 and of the orders +1 and -2 can easily be obtained from the generalized theory of Raman and Nath. The formulae are the same as those obtained by a more involved perturbation calculation by Bhatia and Noble.

535.42 : 534.32

2254 DIFFRACTION OF LIGHT SUPERPOSED ULTRASONIC WAVES.
J.Satyanarayana Murty and B.Ramachandra Rao.
Z. Phys., Vol.157, No.2, 189-97 (1959).

A method of generating, simultaneously, two sound waves of frequencies in the ratio 1 : n, whose phase difference can be continuously varied, is described. The diffraction of light by such waves is studied, using frequencies in the ratio 1 : 2 and 1 : 3. Quantitative measurement of the intensities of the various orders is carried out, at phase angles of 0, $\pi/2$ and π in case of 1 : 2 waves and at phase angles of 0 and π in case of 1 : 3 waves. The measured intensities compared very well with values calculated on the basis of the simple theory worked out by Murty (Abstr. 1635 of 1955). Photographs, showing the general features of diffraction by superposed waves, have also been reproduced.

535.43

2255 THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. VII. DISSYMMETRY IN UNPOLARIZED AND POLARIZED LIGHT.
W.Heller and M.Nakagaki.
J. chem. Phys., Vol. 31, No. 5, 1188-95 (Nov., 1959).

For Pt VI, see Abstr. 6798 (1959). Light scattering of non-absorbing colloidal spheres is calculated, on the basis of the Mie theory, for the angles of observation, γ, of 45° and 135°. The parameters considered are $\alpha = 0.2\ (0.2)\ 15.2$ and $m = 1.20$. The scattering ratio is derived for both angles, for both unpolarized and linearly polarized light. Numerical data are given for the dissymmetry in both unpolarized and polarized light. A graph is included for an easy, approximate calculation of dissymmetries at any m values within the range 1.00-1.25. The maxima and minima of light scattered at 45° and 135° and of the dissymmetry are discussed, and a simple equation is given for deriving the α values at which they occur if $m \to 1.0$. The results are compared with alternate ones derived from the Rayleigh–Gans and Debye equations.

535.56

2256 HELICAL KERR CELL.
E.F.Dawson and N.O.Young.
J. Opt. Soc. Amer., Vol. 50, No. 2, 170-1 (Feb., 1960).

A cell having a pair of helical electrodes and containing material exhibiting the Kerr electrostatic effect is shown to give a pure optical rotation proportional to the fourth power of the electrostatic field. Experiments in support of the theory are described.

535.56

2257 THE OPTICAL ROTATORY DISPERSION OF QUARTZ.
S.Chandrasekhar.
Proc. Indian Acad. Sci. A, Vol. 45, No. 3, 147-60 (March, 1957).

Many formulae have been proposed to express numerically the rapid increase of the rotatory power of quartz with decrease of wavelength. An examination of these formulae shows that they are wholly inappropriate for the case of quartz. It has been shown that the entire range of data from the visible to the extreme ultraviolet is accurately represented by a new type of formula involving only two constants, viz.,

$$\rho = \frac{k\lambda^2}{(\lambda^2 - \lambda_0^2)^2},$$

where $k = 7.19$ and $\lambda_0 = 0.092\,628\,3\ \mu$. A theoretical interpretation of the new formula has been given on the basis of a simple coupled oscillator model.

COLORIMETRY . PHOTOGRAPHY

535.65

2258 USE OF A DIGITAL READOUT UNIT IN CONVERTING SPECTROPHOTOMETRIC DATA TO COLOR COORDINATES. F.W.Billmeyer, Jr.
J. Opt. Soc. Amer., Vol. 50, No. 2, 137-43 (Feb., 1960).

Spectrophotometric data are automatically entered on I.B.M. punched cards by means of a Librascope Digital Readout Unit for the General Electric Recording Spectrophotometer. Conversion to colour coordinates is subsequently carried out on an I.B.M. 650 computer. The over-all precision of the spectrophotometer-digitizer-computer system corresponds to 95% confidence limits of about 0.001 in trichromatic coefficients x and y or about 0.7 NBS units of colour difference (Adams chromatic value formula, normalized as in A.S.T.M. Method D1482-57T). Taking results of the National Bureau of Standards as correct, the accuracy of the average of several measurements is within 0.0005 in trichromatic coefficients or 0.4 NBS units of colour difference. The error frequency of the digitizer is currently below 1 in 7000 readouts, and can be reduced to less than 1 in 200 000 readouts.

535.65

2259 ANALYTICAL DENSITOMETRY FOR COLOR PRINT EVALUATION. J.W.Onley.

J. Opt. Soc. Amer., Vol. 50, No. 2, 177-82 (Feb., 1960).

For a wide gamut of dye combinations for a reflection print material, equivalent neutral densitometry is shown to compare favourably with colorimetric measurements for the evaluation of colour prints. Over a limited range of normal printing conditions, there is a linear relation between reflection density (E.N.D.) and distance from the illuminant point along the vectors of a colorimetric dye grid. Both neutral scale and picture-area densitometry offer advantages for the measurement of matched and rejected prints. It is necessary to bear in mind the possible limitations of neutral scale densitometry and to utilize picture area measurements for reproductions in which conditions vary considerably from "normal".

77

2260 PARTICLE PHOTOGRAPHY. [Premier Colloque International de Photographie Corpusculaire].

Paris: Centre National de la Recherche Scientifique (1958) 451 pp. [Colloques Internationaux du Centre National de la Recherche Scientifique No. 79]. In French.

For abstracts of the papers presented at the above conference see Abstr. 12545, 12922-4, 12926, 13404, 13549, 13987-8, 13992-14016 (1959), 190-202 (1960).

77

2261 PARTICLE PHOTOGRAPHY [Photographic Corpusculaire. II]. Edited by P.Demers.

Montreal: Les Presses Universitaires de Montreal (1959) 459 pp.

The second international conference was held at Montreal in 1958. There were 86 papers with discussions divided into 6 sections. Abstracts of individual papers will be found under appropriate headings in this or succeeding issues of "Science Abstracts".

77

2262 OPTIMIZATION OF FRAME RATES FOR HIGH-SPEED PHOTOGRAPHY. T.P.Rona and C.L.Feldman.

Rev. sci. Instrum., Vol. 30, No. 10, 902-7 (Oct., 1959).

The numerical results obtained from high-speed photography are examined in order to determine the frame rate best suited to a given phenomenon. Procedures for optimum frame rate determination are shown for deterministic and random space-time functions with emphasis on error reduction in velocity measurements. Characteristics of the random errors of a typical high-speed camera are given.

77 : 535.33

2263 MEASUREMENTS OF [PHOTOGRAPHIC] BLACKENING ON SPECTRAL LINES. K.D.Mielenz.

Z. InstrumKde, Vol. 67, No. 2, 28-30 (Feb., 1959). In German.

Measurements on photographed spectrum lines show increasing transmissions as the aperture of the measuring photometer is increased to collect more scattered light. The variation is considered theoretically assuming a cosine distribution of scatter. Measurements on different photometers may be made coincident by adjusting their apertures; but this is not reliable if the photometers receive different amounts of false light. G.F.Lothian

77 : 539.1.07

THE MEASUREMENT OF IONIZATION IN PHOTOGRAPHIC EMULSIONS. See Abstr. 2469

HEAT . RADIATION

536.2 : 539.17

TEMPERATURE DISTRIBUTION IN A FINITE UNSHEATHED CYLINDER WITH TIME DEPENDENT DISTRIBUTION OF HEAT SOURCES. See Abstr. 1460

536.3

2264 THE MEASUREMENT OF OPTICAL RADIATION. E.J.Gillham.

Research, Vol. 12, No. 10-11, 404-11 (Oct.-Nov., 1959).

Methods used in a standardizing laboratory for making absolute measurements of radiation in the ultraviolet, visible and infrared, are described, emphasizing mainly radiation detectors of the thermal type, including absolute radiometers, and how they are used either for direct measurement, or for calibration of other detectors.

536.3

2265 THE THRESHOLD OF SENSITIVITY OF SELECTIVE OPTICO-ACOUSTIC RADIATION RECEIVERS. A.O.Sail'.

Zh. tekh. Fiz., Vol. 29, No. 3, 344-5 (1959). In Russian.

An expression is given for the force acting on an optical microphone system, and this is related to the power changes which occur due to thermodynamic considerations. For calculation of the acoustic resistance it is necessary to consider the thermal properties of the gas and the heat conduction through the walls of the system; the sensitivity threshold is obtained by relating the gas composition with a heat balance for the gas volume, and a numerical example is given. P.G.Morgan

536.33

2266 THE DETECTION OF THERMAL RADIATION USING LINEAR EXPANSION. R.V.Jones.

Proc. Roy. Soc. A, Vol. 249, 100-13 (Jan. 1, 1959).

A thermal radiation detector has been made which depends on the expansion of a thin metallic strip a few millimetres long. Expansions of the order of 10^{-13} to 10^{-10} cm are converted into rotations of 10^{-10} to 10^{-8} rad by means of a mechanical system using a galvanometer-type suspension strip as a flexure pivot. The rotations are measured with an optical lever and photoelectric amplifying system. Constantan 0.1 μ thick is employed as the expansion material, and the receiving area is about 1 mm^2. The device has been developed primarily to see whether the thermal fluctuation limit of sensitivity could be more closely approached than has been possible with conventional detectors. The limit for the expansion detector is shown to arise from the radiation damping of oscillations in the expansion strip, giving the standard result for a receiver of a given area. Observations on several of the best of the expansion devices show that they come within a factor of between two and three of the best possible sensitivity for a receiving area of 1 mm^2, achieving a noise equivalent signal of less than 1.5×10^{-11} W for a bandwidth of 1 c/s.

536.33 : 621.317.79

2267 SIMPLIFIED LOGARITHMIC RADIATION METER USING NOISE. C.E.Cohn.

Rev. sci. Instrum., Vol. 30, No. 12, 1097-9 (Dec., 1959).

A logarithmic radiation meter has been developed which uses an a.c.-coupled logarithmic voltmeter to measure the random noise from a photomultiplier detector. A range of four decades has been obtained.

536.33

2268 EMISSIVITY OF DISPERSED CARBON PARTICLES. V.R.Stull and G.N.Plass.

J. Opt. Soc. Amer., Vol. 50, No. 2, 121-9 (Feb., 1960).

The emissivity of spherical carbon particles is calculated in both the infrared and visible regions of the spectrum. The scattering and absorption cross-sections for individual particles are obtained from the Mie theory of scattering. A suitable dispersion equation is derived which represents the optical properties of carbon flame temperatures. An expression is obtained for the radiation intensity emitted by a large number of dispersed particles which includes all higher order scattering processes. From these results the emissivity of carbon particles in flames is calculated for particle radii in the range from 50 to 800 A and for 10^6 to 10^{10} particles cm^{-3}. In addition the emissivity is obtained for several different particle size distributions which are representative of actual flames. A quantitative explanation is given for the occurrence of the intensity maximum at shorter wavelengths than corresponds to the blackbody maximum at the same temperature.

536.42

2269 COMMENTS ON "CONDENSATION IN NOZZLES". P.P.Wegener and L.M.Mack.

J. appl. Phys., Vol. 30, No. 10, 1624 (Oct., 1959).

Attention is drawn to an extensive literature on condensation in rocket and wind-tunnel nozzles, which should be used in any extension of the work of Wilde (Abstr. 6838 of 1959). J.G.Oldroyd

536.46 : 533.6

2270 A STUDY OF COMBUSTION IN SUPERSONIC FLOW. R.A.Gross.

Research, Vol. 12, No. 10-11, 381-9 (Oct.-Nov., 1959).

Describes an exploratory experimental search to learn what phenomena are actually encountered when releasing chemical energy in supersonic flow. Steady, stable, standing plane and oblique detonations were produced for the first time in the laboratory. A new

ignition hysteresis phenomenon which has important theoretical consequences was observed. Measured wave properties were compared with theoretical predictions for hydrogen-air and methane-air detonations. This research lays the groundwork for new chemical production methods, new hypersonic propulsion systems and provides a powerful tool in the study of chemical kinetics.

536.46 : 537.56

ABSORPTION AND DISPERSION OF MICROWAVES IN FLAMES. See Abstr. 1098

536.5

2271 THE FREEZING POINTS OF HIGH PURITY METALS AS PRECISION TEMPERATURE STANDARDS. V. THERMAL ANALYSES ON 10 SAMPLES OF TIN WITH PURITIES GREATER THAN 99.99 + %. E.H.McLaren and E.G.Murdock.
Canad. J. Phys., Vol. 38, No. 1, 100-18 (Jan., 1960).

For Pt IV see Abstr. 1383 (1959). Extensive thermal analyses have been made on 10 samples (suppliers' analysed impurity contents < 0.2 to < 100 p.p.m.) of high purity tin, including zone-refined metal; liquidus points have been intercompared with a precision of about 0.0002°C and alloy melting ranges have been examined following different types of freezing with and without overnight anneals near the solidus temperature. Samples of nominal 99.9999% purity tin were found to have such narrow alloy melting ranges that any ambiguity, arising from unknown impurity concentrations, in specifying the liquidus point of pure tin is well inside 0.001°C; a value of 231.913°C (Int. 1948) was found for the standard liquidus point of pure tin. An account is given of the supercooling that was observed on the bulk samples and of anomolous structures that were found on melting curves. An appendix gives the results of long-term intercomparisons of the temperatures realized in four water triple point cells.

536.5 : 621.317.39

2272 A SURVEY OF TEMPERATURE MEASURING TECHNIQUES. W.A.Seatherton.
Brit. Commun. and Electronics, Vol. 6, No. 10, 700-10 (Oct., 1959).

536.52

2273 ON THE MEASUREMENT OF THE TEMPERATURES OF UNENCLOSED OBJECTS BY RADIATION METHODS.
A.G.Emslie and H.H.Blau, Jr.
J. Electrochem. Soc., Vol. 106, No. 10, 877-80 (Oct., 1959).

The functional relationships between apparent temperature and true temperature for the total radiation pyrometer, the optical pyrometer, the two-colour pyrometer, and the two-temperature pyrometer are developed and discussed. It is shown that it is impossible to measure the temperature of an unenclosed object in the range 2000-4000°K with accuracy greater than about 10% without prior knowledge of the emissivity. If the emissivity is known within 20%, the temperature can be determined within 1 or 2% by means of an optical pyrometer, particularly if the instrument is operated at the blue end of the spectrum. The accuracy obtainable with the other instruments under equivalent conditions is significantly lower.

536.53 : 534.22

2274 THIN-FILM THERMOMETER MEASUREMENTS IN PARTIALLY IONIZED SHOCK-TUBE FLOWS.
P.V.Marrone and R.A.Hartunian.
Phys. of Fluids, Vol. 2, No. 6, 719-21 (Nov. - Dec., 1959).

In making resistance-gauge measurements of heat transfer to the walls of a shock tube, electrical effects, including shorting of the gauges by ionized gas, are troublesome. Of several methods used to overcome the difficulty, the most successful is an insulating coating of SiO_2, made by evaporating silicon monoxide. For studying heating by surface catalysis, it is possible to evaporate metallic films on top of the SiO_2. A.G.Gaydon

536.6

2275 A NEW METHOD OF DETERMINING THERMAL CHARACTERISTICS AND THERMAL EFFECTS BY MEANS OF A THERMOGRAPH. M.S.Yagfarov.
Dokl. Akad. Nauk. SSSR, Vol. 127, No. 3, 615-17 (July 21, 1959). In Russian.

The apparatus consists essentially of a steel cylinder with two symmetrically placed holes, one of which contains material of known thermal characteristics and the other the material to be investigated. The temperature of the cylinder is raised by means of an electric heater and the temperature of the sample and control materials is measured by means of thermocouples. A direct comparison of the thermal characteristics can therefore be made, up to temperatures of ~ 1000°C. Measurements of the specific heat potassium nitrate over the temperature range 50 - 240°C are given in detail. H.C.Cole

536.62

2276 QUASI-STATIONARY MEASUREMENT OF THE SPECIFIC HEAT AND THE THERMAL CONDUCTIVITY OF PLASTICS. K.H.Hellwege, W.Knappe and V.Semjonow.
Z. angew. Phys., Vol. 11, No. 8, 285-90 (Aug., 1959). In German.

The cylindrical specimen has an embedded heating coil which provides a constant wattage. The rate of rise of temperature of the specimen is measured to determine the specific heat, and the temperature difference between two points within the specimen to determine the thermal conductivity. The specimen is maintained in vacuo and surrounded by an adiabatic mantle. The apparatus is described in detail and illustrated. The temperature range covered is −150 to 100°C and results are shown graphically for silicone rubber, plasticized PVC and other plastics. The specific heat of cold-hardened silicone rubber has an abrupt change at −39°C. S.Weintroub

536.62

2277 CALORIMETRIC DETERMINATION OF THE STORED ENERGY IN COLD WORKED COPPER WIRE.
R.Sizmann and H.Wenzl.
Z. angew. Phys., Vol. 11, No. 9, 362-5 (Sept., 1959). In German.

A massive copper block which contains the specimen is heated at a constant rate (0.5-10°C/min). The temperature of the specimen (approx. 1 g) is compared with that of the Cu block using Pt resistance coils (100 ohm at 0°C) in an a.c. bridge. The bridge is also supplied with d.c., enabling the specimen and the block to be maintained at the same temperature. This current is recorded, a temperature difference of 1/100°C being detectable. J.E.Caffyn

THERMODYNAMICS

536.7

2278 POLYNOMIAL REPRESENTATION OF THERMODYNAMIC TABLES. C.J.Pings.
Nature (London), Vol. 184, 444-5 (Aug. 8, 1959).

Berry, Black and Enderbury have used Chebyshev polynomials to represent the steam tables of Keenan and Keyes giving volume, enthalpy and entropy as orthogonal polynomial expansions in temperature and pressure. It is pointed out that the expansion of volume as a function of temperature and pressure and an expansion of the isobaric heat capacity as a function of temperature at zero pressure provide all the information necessary for the computation of other thermodynamic functions. Methods of performing the mathematical processes required are discussed briefly and the advantages of using the equation of state in the Chebyshev form are considered. F.E.Hoare

536.7

2279 AN ESSENTIALLY STATISTICAL APPROACH TO THERMODYNAMIC PROBLEMS—II. M.Dutta.
Proc. Nat. Inst. Sci. India A, Vol.21, No.6, 373-81 (Nov. 26, 1955).

For previous work see Abstr. 1273 (1954). In this paper, the thermodynamic behaviour of systems of different types, viz. those of black-body radiation, of matter and radiation, and of mixtures, has been investigated by the general statistical method, developed by Dutta (1953). Expressions for thermodynamic functions microscopic distributions, fluctuations, etc., have been obtained in the form given by Fowler [Statistical Mechanics, 2nd Edition, Cambridge University Press, Cambridge (1936)]. It is seen that for investigations of microscopic properties, the introduction of any assumption about microscopic nature is not at all necessary. This assumption is to be introduced only for discussions of microscopic distributions or the like.

536.7 : 538.56 : 537.52

OPTICAL MASERS: POSSIBILITY OF NEGATIVE TEMPERATURE PRODUCTION. See Abstr. 1109

LOW-TEMPERATURE PHYSICS

536.48 : 536.42

2280 CONTRIBUTION TO THE THEORY OF THE POMERANCHUK EFFECT IN He^3. D.G.Sanikidze.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 279-80 (July, 1958). In Russian. English translation in : Soviet Physics–JETP (New York), Vol. 35(8), No. 1, 192-3 (Jan., 1959).

Pomeranchuk predicted that the melting curve of He^3 would have a minimum on the (p,T) diagram and that below this minimum the heat of melting would be negative. Making use of the known form of the (p,T) diagram above the minimum and an assumed energy spectrum, it is shown that the value of the melting temperature, at the same pressure, below the minimum may be found and hence the whole melting curve plotted. In this way it is found that the minimum should occur at $T \sim 0.5^\circ K$ and $p \sim 30$ atm. The maximum (negative) heat of melting is at about $0.25^\circ K$. F.E.Hoare

536.48

2281 VELOCITY OF SOUND IN LIQUID He^3 AT HIGH PRESSURES. K.R.Atkins and H.Flicker.
Phys. Rev., Vol. 116, No. 5, 1063-5 (Dec. 1, 1959).

The velocity of 14-Mc/s sound in liquid He^3 was measured at pressures up to 9 atm in the temperature range 1.2° to $3.2^\circ K$. A few measurements were also made in the gas just above the critical temperature. A possible phonon contribution to the thermal coefficient of expansion of the liquid is discussed.

536.48

2282 DIFFRACTION OF THERMAL WAVES IN LIQUID HELIUM II BY A SPHERICAL MIRROR. J.Fajans.
Phys. Rev., Vol. 116, No. 5, 1066-8 (Dec. 1, 1959).

Diffraction patterns of 3 and 13 kc/s thermal waves in He II caused by a spherical mirror were measured. The main features of the patterns were developed from the Kirchoff diffraction formula combined with a standing wave distribution. Both the amplitude and phase of the wave at each point of space could be determined.

536.48

2283 LATENT HEAT OF EVAPORATION OF LIQUID He^4 AND LIQUID He^3. S.K.Trikha and V.S.Nanda.
Proc. Nat. Inst. Sci. India A, Vol.21, No.6, 363-7 (Nov. 26, 1955).

Latent heat of evaporation of He^4 and He^3 is calculated by using the Clausius–Clapeyron equation. Since in case of He^4, satisfactory agreement between the theoretical and the experimental latent heat values is observed, therefore the calculated He^3 values can be used with confidence in further thermodynamical computations. The latent heat values for He^3, as calculated by using Chen and London (Abstr. 3254 of 1953) vapour-pressure equation, differ considerably from those calculated by Abraham et al. (Abstr. 1805 of 1950) in the temperature range $1.0^\circ K$ to $0.0^\circ K$. Thus experimental results of latent heat of He^3 below $1.0^\circ K$ should aid decision on whether or not a transition in He^3 exists below $1.0^\circ K$.

536.48

2284 EFFECT OF THE VAN DER WAALS' CORRECTIONS ON THE TRANSITION TEMPERATURE OF He^3–He^4 MIXTURES. S.M.Bhagat.
Proc. Nat. Inst. Sci. India A, Vol. 21, No. 3, 165-9 (May 28, 1955).

536.48

2285 IONS IN LIQUID HELIUM. K.R.Atkins.
Phys. Rev., Vol. 116, No. 6, 1339-43 (Dec. 15, 1959).

The mobility of an ion in liquid He^4 is known to be appreciably less than the mobility of a He^3 atom and varies in a different way with temperature. It is suggested that the essential difference is that electrostriction effects increase the liquid density over a large region surrounding the ion, so that the ion drags around with it about 50 He^4 atoms. The density field of the positive ion is calculated in a semiclassical approximation. A possible difference between the density fields for positive and negative ions is briefly discussed. Various experimental ways of checking this picture of an ion are suggested.

536.48

2286 SPIN ALIGNMENT IN THE SUPERCONDUCTING STATE. P.W.Anderson and H.Suhl.
Phys. Rev., Vol. 116, No. 4, 898-900 (Nov. 15, 1959).

It is argued that spin alignment can and will occur for ion-core spins in superconductors, but that the alignment is in the form of extremely small domains. Central to the argument is the concept of the nonlocal susceptibility $\chi(r-r')$, which leads to a positive short-range Kittel–Ruderman–Yosida interaction of ion-core spins, but a negative long-range interaction of range ξ_0. Very general arguments suggest that purely ferromagnetic alignment should not be observed in preference to this domain-like "cryptoferromagnetic" alignment.

536.48

2287 THE PROPERTIES OF THE RESISTANCE HYSTERESIS LOOPS IN THE TRANSITION REGION TO SUPERCONDUCTIVITY. W.Meissner and R.Doll.
Z. Phys., Vol.156, No.3, 488-502 (1959). In German.

Further measurements with the tin wire of Abstr. 11048 of 1959 gave the following results. Repeated courses through the hysteresis loops give the same curves. Clamped-on potential leads give the same results as those soldered to form a point contact in a manner that damages the surface of the wire as little as possible. At the highest measuring currents the temperature difference between wire and helium bath is only 0.04°. Oscillograph measurements show stepwise changes of resistance in the transition region. The shape of the transition curve, the occurrence of steps and the origin of the hysteresis are discussed theoretically. H.London

536.48

2288 MILLIMETER WAVE ABSORPTION IN SUPERCONDUCTING ALUMINUM. I. TEMPERATURE DEPENDENCE OF THE ENERGY GAP. M.A Biondi and M.P.Garfunkel.
Phys. Rev., Vol. 116, No. 4, 853-61 (Nov. 15, 1959).

Measurements of the temperature dependence of the microwave absorption in superconducting aluminium were made in the wavelength region 3-20 mm. The results, when plotted as isotherms of surface resistance ratio versus photon energy, show that, at a well-defined energy for each temperature, there is a rapid rise in absorption with increasing energy. This is interpreted as the onset of absorption resulting from direct excitation of electrons across a forbidden energy gap. The isotherms then permit the determination of the temperature dependence of this energy gap. At absolute zero the gap value is found to be $\epsilon_g(0) = (3.2 \pm 0.1)kT_c$ (where $T_c = 1.178^\circ K$) is the superconducting transition temperature), in reasonable agreement with the theoretical value of $3.52kT_c$ obtained by Bardeen, Cooper, and Schrieffer (Abstr 1708 of 1958). Furthermore, the temperature variation of the gap exhibits the same shape as that given by the theory. Finally, reasonable agreement is obtained between theory and experiment concerning the detailed shapes of the surface resistance versus temperature curves over the measured wavelength range, provided that the experimental value $\epsilon_g(0)$ is used in the theory.

536.48

2289 MILLIMETER WAVE ABSORPTION IN SUPERCONDUCTING ALUMINUM. II. CALCULATION OF THE SKIN DEPTH. M.A.Biondi and M.P Garfunkel.
Phys. Rev., Vol. 116, No. 4, 862-7 (Nov. 15, 1959).

The skin depth in superconducting aluminium is calculated from the measured frequency dependence of the surface resistance through the Kronig–Kramers integral transforms. At absolute zero, it is found that the skin depth δ is independent of frequency at low frequencies but begins to increase higher. The maximum rate of increase of δ occurs when the photon energy equals the gap energy, $h\nu = 3.2kT_c = \epsilon_g$; at this point $\delta(h\nu = \epsilon_g)/\delta(h\nu = 0) \cong 1.12$. The maximum value of δ occurs at $h\nu \cong 4\ kT_c$. The superconducting penetration depth λ [i.e., $\delta(h\nu = 0)$] is found to vary approximately as $\lambda(t) = \lambda(0)(1-t^4)^{-1/2}$, with $\lambda(0) = 5.15 \times 10^{-5}$ cm and $t = T/T_c$. The effects of changes in the skin depth have been eliminated from the determination of the energy gap by calculation of the real part of the complex conductivity, σ_r. The energy gap values deduced from the behaviour of σ_r differ only slightly from the results obtained directly from the surface resistance measurements

536.48

2290 SUPERCONDUCTIVITY OF IRON FILMS. Yu.G.Mikhailov, E.I.Nikulin, N.M.Reinov and A.P.Smirnov.
Zh. tekh. Fiz., Vol. 29, No. 7, 931-2 (1959). In Russian.

Freshly-formed Fe films, vacuum-deposited (at a rate not greater than several A/min) on glass substrates at liquid He temperature, became superconducting at $4.2^\circ K$. Films, formed under these conditions and thicker than 10^{-5} A, had a tendency to disintegrate; the higher the temperature of the substrate during

vacuum deposition, the lower was the critical thickness of the film, which disintegrated also on heating to liquid H temperature. The observed superconducting properties of Fe films were attributed to the presence of a second, non-ferromagnetic phase.

M.H.Sloboda

536.48

2291 NOTE ON SUPERCONDUCTING TANTALUM FILMS. J.F.Marchand and A.Venema.

Philips Res. Rep., Vol. 14, No. 5, 427-9 (Oct., 1959).

It appears that thin superconductive tantalum films are difficult to produce. In this note it is shown how such films can be made by evaporation under extremely low pressure. The films thus prepared have been found to exhibit practically the same superconductive properties as the bulk material.

536.48

2292 RESISTANCE TRANSITIONS IN SUPERCONDUCTING TANTALUM. D.P.Seraphim and R.A.Connell.

Phys. Rev., Vol. 116, No. 3, 606-12 (Nov. 1, 1959).

A study was made of the superconducting to normal transition in outgassed tantalum wires induced by the application of an external longitudinal magnetic field. It was found that in most cases the transition as determined from resistance measurements, consisted of an almost discontinuous appearance of resistance, followed by a rather gradual rise in resistance until the full residual resistance was restored. Flux measurements showed that the sharp portion of the transition corresponded to the magnetic, or "bulk" transition. The behaviour of the broad portion of the transition was of the type commonly associated with superconducting "filaments". Although the "filamentary" properties were found to be extremely sensitive to localized contamination and the thermal history of a specimen, they did not appear to depend exclusively on such inhomogeneities, and a systematic variation with residual resistance could be discerned. Plastic deformation altered the characteristics only in proportion to the corresponding increase in residual resistance. A small amount of supercooling which was independent of the "filamentary" phenomena was sometimes observed in the "bulk" transition.

536.48

2293 INTERMEDIATE STATE OF HARD SUPERCONDUCTORS. A.L.Schawlow, G.E.Devlin and J.K.Hulm.

Phys. Rev., Vol.116, No.3, 626-7 (Nov. 1, 1959).

The very large domains found in the intermediate state of hard superconductors are investigated. It is found that pure, annealed rhenium shows fine domains like other soft superconductors, but that coarse domains can be produced by cold-working the sample. Thus the large domains are not due to peculiar electronic properties of the hard superconductors, but to locally strained or impure boundary regions.

ELECTRICITY

ELECTRICAL MEASUREMENTS

537 : 621.3

2294 THE SELECTION AND DESIGN OF EXPERIMENTS FOR ALTERNATING CURRENT TEACHING. H.V.Beck.

Contemporary Physics, Vol. 1, No. 1, 49-55 (Oct., 1959).

The need for careful selection and design of experiments is stressed. The aims and other aspects of practical class teaching are examined and a method of appraising the educational content of a class as a whole is described with particular reference to alternating current experiments. Some general results of such an appraisal are given.

537.7 : 537.54 : 621.317.32

2295 PRECISION CAPACITOR DIVIDER METHOD FOR MEASURING HIGH VOLTAGES.

H.V.Larson and I.T.Myers.

Rev. sci. Instrum., Vol. 30, No. 11, 1022-4 (Nov., 1959).

A high-precision capacitor divider method for measuring the voltage on the terminal of a 2 MV Van de Graaff accelerator is described. Calibration of the system was done using the Be(γ,n) threshold reaction. Linearity was tested using a total beam calorimeter and a beam current integrator.

537.7 : 621.317.733

2296 ACCURATE HIGH-SPEED VOLTAGE COMPARATOR. D.S.Robertson, B.F.Wadsworth and S.E.Brown.

Rev. sci. Instrum., Vol. 30, No. 10. 896-8 (Oct., 1959).

A new high-speed voltage comparator using a silicon capacitor bridge is described. For an input signal with a rate of change of 300 V/sec, the resolution is better than 1 mV. The performance of the circuit is discussed and results are given.

537.7 : 621.317.713

2297 LOW-IMPEDANCE ELECTRONIC COULOMETER. J.B.Hudson and F.E.Dickey.

Rev. sci. Instrum., Vol. 30, No. 11, 1020-1 (Nov., 1959).

An electronic coulometer is described which has 15 Ω input impedance, precision of 0.003 C/min, and long time stability of 0.1% of full scale value. Its calibration and testing are described, and means of adapting it to other operating conditions are given.

537.7 : 621.317.755

2298 NEW METHOD FOR GRAPHICAL REPRODUCTION OF CATHODE-RAY OSCILLOGRAMS.

R.K.Swank and A.Mroz.

Rev. sci. Instrum., Vol.30, No.10, 880-4 (Oct., 1959).

An automatic device for tracing the wave form of a repetitive oscilloscope has been developed. The waveform is accurately reproduced and enlarged by a conventional X-Y recorder. Because optical and pulse techniques are used, the system is capable of reproducing signals displayed on even the fastest available oscilloscopes. When used with a h.f. travelling-wave oscilloscope the method is applicable to phenomena in the millimicrosecond region and is capable of utilizing time resolution down to 0.1 mμsec. Deflection as small as 1 μ may be detected. In addition to making oscilloscope measurements faster and more convenient, certain distortions normally encountered in oscilloscopes are obviated.

537.7 : 621.375.4

2299 TRANSISTORIZED DISTRIBUTED AMPLIFIER. C.W.McMullen.

Rev. sci. Instrum., Vol. 30, No. 12, 1109-13 (Dec., 1959).

Some analytical and experimental results are given for a transistorized distributed amplifier using the common emitter configuration. The characteristic impedances of the base and collector transmission lines are both 43.4Ω. A 4-section amplifier stage yields a mid-frequency gain of 5.1 dB and an upper half-power frequency of 290 Mc/s. The low-frequency response is reasonably constant down to 10 c/s.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

537.2 : 621.315.61

2300 DIGEST OF LITERATURE ON DIELECTRICS. VOLUME 22. 1958.

Edited by R.A.Soderman and L.J.Frisco.

Washington, D.C.: National Academy of Sciences — National Research Council Publication 713 (1959) 292 pp.

This annual volume is prepared by the Committee on Digest of Literature of the Conference on Electrical Insulation, Division of Engineering and Industrial Research. The papers are: Instrumentation and measurements, H.P.Hall and A.E.Sanderson (1-26) 270 refs. Table of dielectric constants, dipole moments and dielectric relaxation times, K.H.Illinger (27-55) 78 refs. Molecular and ionic interactions in dielectrics, T.D.Callinan (57-73) 148 refs. Conduction phenomena in solid dielectrics, J.Rolfe and F.R.Lipsett (75-98) 154 refs. The breakdown of dielectrics, J.C.Devins and S.I.Reynolds (99-119) 142 refs. Ferroelectric and piezoelectric materials, W.R.Cook, Jr and H.Jaffe (121-47) 339 refs. Ferromagnetic materials, K.Dwight, N.Menyuk, R.Arnott, M.Cohen, J.B.Goodenough, E.E.Huber, Jr, D.O.Smith, R.F.Soohoo, G.P.Weiss, A.Wold and D.G.Wickham (149-207) 500 refs. Rubber and plastic insulation, S.Palinchak and B.Bennett (209-38) 186 refs. Insulating films, H.A.Birdsall (239-51) 64 refs. Insulating liquids and their applications, D.H.Hogle (253-61) 41 refs. Ceramic insulation, J.G.Leschen (263-9) 53 refs. Engineering applications, E.S.Yates; C.A.Long; A.J.Warner (271-2, 272-5, 275-92) 164 refs.

537.2

2301 AN APPROXIMATE METHOD OF DIELECTRIC MEASUREMENT IN THE CENTIMETER WAVE REGION. H.Seno.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 123-32 (April, 1959).

An approximate method of microwave dielectric measurement is described for comparatively high loss materials utilizing the standing wave in the rectangular waveguide. This method has been devised on the basis of the fundamental equation for the measurement which was previously derived from Maxwell's equations under the boundary conditions in the guide system. The experimental results obtained by this method for several samples in the 3 cm wavelength region are also described. From the agreement of these results with the theory and from the simplicity of both procedure and calculation in the measurement, it may be concluded that this method is practical.

537.2

2302 A METHOD OF MEASURING THE COMPLEX PERMITTIVITY AND NON-LINEAR PROPERTIES OF DIELECTRICS IN THE DECIMETRE WAVE BAND. J.Fousek.
Czech. J. Phys., Vol. 8, No. 6, 732-9 (1958). In Russian.

An apparatus for measuring the complex permittivity of small specimens of dielectric substances in the decimetre wave band is described. Non-linear properties of the dielectric can be measured in this band and also their variation at low frequencies. The method is particularly suitable in studying ferroelectric materials, and has been used to find the dependence of ϵ' of an X-cut Rochelle salt on the low frequency current flowing through the specimen. An examination of non-linear resistance materials could also be made with this arrangement. K.N.R.Taylor

537.2 : 541.18

2303 MEASUREMENT OF CONTACT POTENTIAL VARIATIONS DURING GAS ADSORPTION AT METAL SURFACES WITH CONSTANT CAPACITY OF THE MEASURING CONDENSER. A.Eberhagen, R.Jaeckel and F.Strier.
Z. angew. Phys., Vol. 11, No. 4, 131-4 (April, 1959). In German.

Describes an arrangement for measuring contact potential between two nickel cylinders separated by a glass wall. This enables an adsorbed film to be deposited on one plate only. A servo-system is used to balance out the contact potential thus making use of a null method. Measurements have been made on the adsorption of oxygen on nickel. T.Mulvey

CURRENT ELECTRICITY
ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

537.3

2304 ON THE FORMATION OF RESISTIVE LAYERS OF ORGANIC ORIGIN ON ELECTRIC CONTACTS. I.Dietrich and M.Honrath-Barkhausen.
Z. angew. Phys., Vol. 11, No. 10, 399-403 (Oct., 1959). In German.

A tracer technique using C^{14} was used to study the formation of thin layers on electrical contacts resulting from the decomposition of organic substances. Two types of layer formation occur; one takes place when current passes through the contacts and the other takes place in the absence of current. Adsorption measurements were made to clarify the latter mechanism but so far these are inconclusive. T.Mulvey

537.3 : 621.317.733

2305 WAGNER-EARTH AND OTHER NULL INSTRUMENT CAPACITY NEUTRALIZING CIRCUITS. H.H.Wolff.
Rev. sci. Instrum., Vol. 30, No. 12, 1116-22 (Dec., 1959).

A simple but exact derivation of the conditions for ground potential on the null instrument input in nongrounded a.c. bridges is given. It is shown that not only the "Wagner-Earth", but also other networks and circuits between the power source and the a.c. bridge can easily fulfill these conditions. Advantages of such other networks and circuits are discussed. General considerations for optimum bridge details for measurements of highest obtainable accuracy are given. Practical supply circuits for a.c. bridges are described. Furthermore, it is shown how the adjustment of the earth capacity neutralizing system can be made in a minimum amount of time.

537.3 : 681.142

2306 USE OF A DIODE RING AS A FOUR-QUADRANT MULTIPLIER. R.H.Wilcox.
Rev. sci. Instrum., Vol. 30, No. 11, 1009-11 (Nov., 1959).

At low-voltage levels a diode ring forms an extremely simple four-quadrant passive analogue multiplier characterized by reliability, stability, and wide bandwidth. Operation is analysed theoretically, and experimental tests are described. These show that with care in selecting diodes and adjusting circuit values, 1% accuracy is obtainable at input levels up to 150 mV.

537.3 : 621.318.424

2307 THEORETICAL AND EXPERIMENTAL ANALYSIS OF THE FERROMAGNETIC EXPLOSIVELY SHOCKED CURRENT PULSE GENERATOR. J.H.Johnson.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 241S-243S (April, 1959).

To most effectively utilize the potential capability of the ferromagnetic explosively actuated current generator one must understand the effect of variation of parameters upon the device output into a given load. Theories of operation of the device, an approximate theoretical analysis of the effect of variation of the basic circuit and device parameters and a comparison of theory with experimental results are given. Theoretical and experimental data are presented and compared for peak current v. circuit load inductance, device load coil turns, and magnetic core width (for a fixed thickness). There is a gratifying similarity between theoretically predicted and experimentally determined data. Guiding criteria are given for an optimum ferromagnetic current pulse generator system.

537.3 : 621.318.3 : 621.316.721

2308 THE STABILITY OF PHOTO-ELECTRIC STABILIZERS FOR MAGNET CURRENTS. K.Weinhardt.
Z. angew. Phys., Vol. 11, No. 10, 403-7 (Oct., 1959). In German.

The frequency response and stability conditions for current stabilizers using galvanometer amplifiers are put into a form which enables a direct comparison with experiment to be made. Tests showed that a short term stability of current of 1 part in 10^6 could be obtained in a mass spectrometer magnet and a stability of 1 in 10^5 for several hours. T.Mulvey

537.3

2309 EFFICIENCY OF A THERMOMAGNETIC GENERATOR. H.E.Stauss.
J. appl. Phys., Vol. 30, No. 10, 1622-3 (Oct., 1959).

A thermomagnetic generator of electricity may be constructed from a ferromagnetic material which lies between the pole pieces of a magnet and which is demagnetized and remagnetized by a heating and cooling cycle operating through the Curie temperature. An e.m.f. is induced in a coil surrounding a specimen of the material as the flux linked with the coil changes. It is shown that the efficiency of converting heat into electrical energy is less than π times the ratio of applied field to the Weiss molecular field. In practice this puts an upper limit of about 10^{-4}% upon the efficiency of conversion. R.Parker

537.3 : 537.56

2310 HIGH-POWER PULSE STEEPENING BY MEANS OF EXPLODING WIRES. G.S.Janes and H.Koritz.
Rev. sci. Instrum., Vol. 30, No. 11, 1032-7 (Nov., 1959).

A circuit technique is described which reduces the rise times of high-power pulses by means of exploding wires. This circuit is a nonlinear lumped parameter transmission line. The magnetic energy is stored in the interstage lead inductances and rapidly transferred into (or more correctly, shared with) succeeding stages by the vaporization of exploding wire resistive fuse elements connected in shunt between the leads. Each of three resistive fuse elements consisted of 20 to 50 parallel 0.001 in. diameter copper wires held in place across a 2 in. gap with pressure sensitive tape. An empirically determined arrangement is described wherein the maximum rate of current rise is increased from 300 000 A/μsec to 800 000 A/μsec. Using this technique, a magnetic field of 10^4 G is built up in 0.15 μsec throughout a volume 4 cm in length and 10 cm in diameter. It is shown that the best results are obtained with high conductivity fuse materials such as copper or aluminium. Similarity theorems are presented for the design of pulse steepening elements for use with circuits having similar pulse shapes but different energies and characteristic impedances.

537.3 : 537.56

2311 "OPEN-CIRCUIT" VOLTAGES IN THE PLASMA THERMOCOUPLE. H.W.Lewis and J.R.Reitz.
J. appl. Phys., Vol.30, No.11, 1838-9 (Nov., 1959).

Extends earlier work (Abstr. 12312 of 1959) to a plasma diode in which a "trickle current" flows, small compared to the cathode emission but large compared to the anode emission current. An expression obtained for the e.m.f. of the cell reduces to kT log (j_a/j), in the case when the electrons near the anode have the temperature T of the cathode (j = current density of anode, j_a = saturation current density anode would emit at temperature T). The analysis is used to explain the results of Pidd and others on the effect of introducing caesium vapour, and the advantage of using a cylindrical diode. B.Meltzer

537.312 : 621.383.8

2312 THE PHOTOVOLTAIC EFFECT AND ITS UTILIZATION. R.Rappaport.
R.C.A.Rev., Vol. 20, No. 3, 373-97 (Sept., 1959).

Use of the photovoltaic effect for converting solar energy directly into electrical energy is described. Attention is given to considerations of the optimum semiconductor material and of how it changes with operating temperature. Experimental results are presented which show operating characteristics and conversion efficiencies of a number of materials including silicon, gallium arsenide, indium phosphide and cadmium sulphide. The high-voltage (~100V) photovoltaic effect obtained with evaporated CdTe films is described. A discussion of the major problems still to be solved is included.

537.36

2313 ALTERNATING CURRENT ELECTRO-OSMOSIS. Z.László.
Acta phys. Hungar., Vol. 10, No. 1, 79-92 (1959). In German.

The phenomenon is to be observed if two liquids e.g. a solution and solvent,are present one on each side of a diaphragm or if the same liquid is present on both sides of an asymmetric diaphragm. The charge distribution occurring in the neighbourhood of the capillary walls is considered to be the chief factor in giving rise to the phenomenon because of the change in the dielectric constant of the liquid by the presence of ions. Variation of different features of the phenomenon is found according as the length of the capillaries is very much greater than or about equal to their radius. The electro-osmotic pressure is a quadratic, the streaming velocity a linear function of the field strength. Temperature and frequency are without influence on the streaming velocity. W.Good

IONIZATION

537.56

2314 IONIZATION PHENOMENA IN GASES. J.Dutton, D.Harcombe and E.Jones.
Nature (London), Vol. 184, 1353-8 (Oct. 31, 1959).

Report of the fourth International Conference held at Uppsala, Sweden during Aug., 1959. About 250 papers were read covering a wide field which included plasma physics as well as fundamental processes and other applications of electric discharges.

537.56

2315 THEORY OF THE TEMPORAL GROWTH OF IONIZATION IN GASES, INVOLVING THE ACTION OF METASTABLE ATOMS AND TRAPPED RADIATION. P.M.Davidson.
Proc. Roy. Soc. A, Vol. 249, 237-47 (Jan. 1, 1959).

There exists no accurate mathematical treatment of the temporal growth of ionization current in a gas due to the primary α ionization process, together with the action of metastable atoms liberating electrons from the cathode as the significant secondary process. The present paper supplies such a treatment. The continuity equation and boundary conditions are derived, and first the solution for the steady state is obtained, showing how the Townsend steady-state formula is modified when this process involving metastable atoms, with some internal destruction in the gas, is present. To derive formulae for temporal growth a contour integral is introduced from which the required solution is obtained in various exact forms. Approximate formulae are also obtained, convenient for calculating both the initial and later stages of the current growth in various practical cases. Another well-known secondary cathode process is that due to fluorescent light, that is, to photons which have been repeatedly absorbed by atoms and re-emitted. Thus, like metastable atoms, they move through the gas by a process of diffusion. Formulae for the resulting current growth are derived. The general case in which, in addition to these diffusion processes, there is secondary cathode action due to unscattered photons and positive ions, is also treated.

537.56

2316 THE ELECTRON IONIZATION COEFFICIENT (α) FOR ORGANIC VAPOURS AND OXYGEN (FROM THE CHARGE STATISTICS OF ELECTRON AVALANCHES). H.Schlumbohm.
Z. angew. Phys., Vol. 11, No. 4, 156-9 (April, 1959). In German.

Describes how the Townsend ionization foefficient α can be determined from avalanche statistics and gives data for CH_4, CO_2, and various polyatomic organic molecules. The accuracy of the method is discussed in some detail. Some data are also given for attachment coefficients in oxygen. J.D.Craggs

537.56

2317 PROBABILITY OF DOUBLE IONIZATION BY ELECTRON IMPACT FOR NEON, ARGON, AND XENON. J.D.Morrison and A.J.C.Nicholson.
J. chem. Phys., Vol. 31, No. 5, 1320-3 (Nov., 1959).

The ionization efficiency curves for the double ionization by electron impact of Ne, Ar, and Xe have been re-examined. It is shown that, near the threshold, the probability of double ionization varies as the square of the excess electron energy. Upper states of the ions are detected and the determination of appearance potentials for such processes is discussed.

537.56

2318 PROBABILITY OF MULTIPLE IONIZATION BY ELECTRON IMPACT. F.H.Dorman, J.D.Morrison and A.J.C.Nicholson.
J. chem. Phys., Vol. 31, No. 5, 1335-7 (Nov., 1959).

The ionization efficiency curves for the 3-fold ionization of A, and the 3, 4, 5, and 6-fold ionization of Xe have been examined. It is shown that, near the threshold, the probability of n-fold ionization varies as the nth power of the excess electron energy for n=3 and 4, and probably also for n=5 and 6. The determination of appearance potentials for such processes is discussed.

537.56

2319 THE NEGATIVE ION H_3^-. V.I Khvostenko and V.M.Dukel'skii.
Zh. eksper. teor.Fiz., Vol.34, No.4, 1026-7 (April, 1958) In Russian. English translation in: Soviet Physics—JETP (New York), Vol.34(7), No.4, 709-10 (Oct., 1958).

Negative ions of mass 2 were observed when H_2O—Sb vapour mixtures were bombarded with 80 eV electrons. Arguments are advanced for identifying the mass-2 ions as H_2^-. J D Craggs

537.56

2320 NEGATIVE IONS OF IRON, COBALT, AND NICKEL. V.M.Dukel'skii and V.M.Sokolov.
Zn. eksper. teor. Fiz., Vol. 35, No. 3(9), 820 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 569-70 (March, 1959).

Using a mass spectrometer, of resolution 100, the authors discovered negative ions Fe^- and Co^- and confirmed the existence of Ni^- ions. The ions were obtained by electron bombardment of $FeCl_2$, $CoCl_2$ and $NiCl_2$. A.E.I. Research Laboratory

537.56 : 535.3

2321 RELATIONSHIP BETWEEN REFRACTIVITY AND IONIZATION POTENTIALS OF ATOMS. S.S.Batsanov.
Optika i Spektrosk., Vol. 6, No. 3, 412-15 (March, 1959). In Russian.

Discusses the relationship between the ionization potentials and refractivity of atoms and ions of elements of groups VI (O, S, Se, Te) and VII (F, Cl, Br, I). A hyperbolic formula is deduced. It is checked by using it to calculate the refractivity of singly and doubly charged ions, R_{ion}. The calculated and experimental values of R_{ion} agree satisfactorily. A.Tybulewicz

537.56 : 539.17

2322 IONIZATION YIELDS FOR FISSION FRAGMENTS. N.G.Utterback and G.H.Miller.
Phys. Rev., Vol.116, No.4, 976-80 (Nov. 15, 1959).

The ratio of fission fragment-to-alpha particle ionization pro-

duced in total stopping was measured in the gases helium, argon, and a helium plus 0.25% argon mixture. A parallel-plate gridded electron collection chamber was used. Gas purity and electron loss were checked by making absolute average energy per ion pair measurements for alpha particles. These agreed with the values reported for total ion collection. The difference in ionization defects between helium and argon consistent with the value predicted by Knipp and Ling (Abstr. 4485 of 1951) on the basis of the greater importance of elastic atomic collisions in argon. Because adding a small amount of argon to helium enables the metastable atoms to produce ionization, the difference in the fission fragment-to-alpha particle ionization ratios between helium and the helium plus argon mixture shows that the ionization-to-excitation ratio in helium is lower for fission fragments than for alpha particles. Arguments are given which indicate that very little "defect" is present for fission fragments in the helium plus argon mixture.

537.56

2323 MOLECULAR IONS. R.N.Varney.

J. chem. Phys., Vol. 31, No. 5, 1314-16 (Nov., 1959).

Physico-chemical analysis of data concerning drift velocities of ions in nitrogen discloses that N_4^+ ions are the stable ones at low temperature and E/p_0 and that the ions dissociate into N_2^+ and N_2 at higher E/p_0, higher temperature, or lower pressure. The dissociation behaves identically with thermal dissociation of molecular gases. The analysis yields the following numerical data: N_4^+ binding energy against dissociation into N_2^+ and N_2, 0.50 eV. Ion temperature in deg K as a function of E/p_0 in volts per cm per mm Hg, $\theta = 12.5\ E/p_0$.

537.56

2324 MASS SPECTROMETRIC STUDY OF CARBON VAPOR. J.Drowart, R.P.Burns, G.DeMaria and M.G.Inghram.

J. chem. Phys., Vol.31, No.4, 1131-2 (Oct., 1959).

The ions C^+, C_2^+, C_3^+, C_4^+ and C_5^+ have been detected in mass spectrometric studies of carbon equilibrium vapour over graphite. Heats of sublimation and average C–C bond energies have been deduced. G.I.W.Llewelyn

537.56

2325 ADVANCES IN THE MASS SPECTROGRAPHY OF POLYATOMIC MOLECULES BY ELECTRON CAPTURE. M.v.Ardenne.

Z. angew. Phys., Vol. 11, No. 4, 121-31 (April, 1959). In German.

To make $XY + e^- \rightarrow [XY]^-$ preponderant over the more usual processes $XY + e^- \rightarrow X^+ + Y^- + e^-$ and $XY + e^- \rightarrow [XY]^- \rightarrow X + Y^-$ in mass spectrometry, a large concentration of slow electrons in a narrow space is required where a vapour of comparatively high density can be introduced. This has been achieved by the magnetic constriction of the electron plasma from a hot cathode-low voltage discharge and also by the production of a quasi-neutral plasma. A positive probe at 40-50 kV immediately behind the source slit has been used to give a negative ion beam of almost uniform velocity so that a resolution between 2500 and 4000 has been obtained by simple magnetic deflection. Mass spectra of oils with groups of lines between M = 450 and 600 have been measured. R.Schnurmann

537.56

2326 TRANSPORT PHENOMENA IN SLIGHTLY IONIZED GASES: LOW ELECTRIC FIELDS. M.S.Sodha.

Phys. Rev., Vol.116, No.3, 486-8 (Nov. 1, 1959).

Chapman and Cowling (The mathematical theory of nonuniform gases. Cambridge: University Press [1953] p.350) have obtained the velocity distribution function in a slightly ionized gas when an electric field E is applied by assuming elastic collisions and validity of Lorentzian approximation. The author has expanded this distribution function, neglecting terms involving fourth and higher powers of field and used this expansion to calculate various transport properties, when a magnetic field is also applied. To simplify mathematics the relaxation time was taken as a power function of electron velocity: Some approximations are also discussed. It is seen that at low electric fields the transport properties can be expressed as linear functions of E^2.

537.56

2327 RANGE OF NITROGEN AND BERYLLIUM IONS IN AIR. Yu.A.Vorob'ev.

Zh. eksper. teor. Fiz., Vol.35, No.5(11) 1306-7 (Nov., 1958).
In Russian. English translation in: Soviet Physics–JETP(New York), Vol.35 (8), No.5, 912 (May, 1959).

Describes data obtained with ions in the velocity range 8×10^8–11.5×10^8 cm/sec using a cloud-chamber technique. The ions were produced in a 72 cm cyclotron. The ranges (values are tabulated) vary from 0.66 to 1.13 cm (normal air). J.D.Craggs

537.56

2328 EQUILIBRIUM PROPERTIES OF A MULTICOMPONENT IONIZED GAS. G.M.Harris.

J. chem. Phys., Vol. 31, No. 5, 1211-20 (Nov., 1959).

A method has been developed for the calculation of the equilibrium properties of an ionized gas consisting of many nuclear and molecular species. An essential feature of the present calculation is that it explicitly considers more than one ionic species per atom and therefore applies to partially ionized atoms and molecules. Free and bound electrons are distinguished by counting as bound electrons all those in the ground state of each ionic species. Molecular species with internal degrees of freedom are also included. The additivity of kinetic and potential energy is assumed, a classical electrostatic potential of interaction is used, and electron degeneracy is inclined only in the kinetic energy terms. The Helmholtz free energy of the system is minimized with respect to the concentration of each species assumed present, thus determining the equilibrium composition of the system as a function of temperature and volume. The thermodynamic quantities of interest are then calculated for an appropriate temperature–volume grid. This method thus allows the effect of the variation of composition on the equation of state to be determined, as well as the delineation of regions in PVT space where the electron degeneracy and electrostatic interaction each becomes important. The model is applied to a system of particles arising from the hydrogen molecule.

537.56

2329 IONIZATION AND [CHARGE] EXCHANGE CROSS-SECTIONS OF HYDROGEN ATOMS AND IONS OF 9-60 keV IN HYDROGEN [GAS]. F.Schwirzke.

Z. Phys., Vol. 157, No. 4, 510-22 (1960). In German.

Describes the measurement of the ionization and charge-exchange cross-sections for H^0, H^+, H_2^+ and H_3^+ in hydrogen gas. The emission of secondary electrons from copper-beryllium by impact of these particles was also measured. A beam of monoenergetic neutral hydrogen atoms was produced by charge exchange of a beam of protons in a gas chamber. Separation of the charged and uncharged components was accomplished by a magnetic field. The pressure in the chamber in which the cross-sections were measured was so low, that only a few particles of the incident beam suffered an effective collision. The positive and negative charges, which were produced by ionization and charge exchange along the path of the beam, were extracted by a transverse electric field and the saturation current was measured. The intensity of the neutral beam was determined at the same time by repeated charge exchange in an 80 $m\mu$ thick foil of aluminium oxide.

ELECTRIC DISCHARGES

537.52

2330 THE TIME DEPENDENCE OF THE LIGHT EMISSION FROM A GAS DISCHARGE. W.Franke.

Z. Phys. Vol.158, No.1, 96-110 (1960). In German.

The time dependence of the light emission due to electron impact was observed in methane and methylal vapours. Single avalanches, their successors and the transition to breakdown was observed. In methylal the rise-time constant of the light emission of single avalanches is compared with the rise-time constant of the electron production (measured by an electrical method). These rise-time constants are found to be equal. In this way a quantum efficiency of 3.5×10^{-4} photons per avalanche electron is derived for methylal. The growth rate of single avalanches of 10^8 electrons is shown to be decreased by space charge. In methane, a series of avalanches were investigated. The electron drift velocity ($v_- = bp \times E/p$; $bp = 2.3 \times 10^6$ torr cm^2 V^{-1} sec^{-1}, $E/p = 40$-110 V Torr^{-1} cm^{-1}) and the average lifetime of excited states ($\sim 7 \times 10^{-9}$ sec) were measured. In methane, the breakdown is produced by series of avalanches, whereas in methylal with its smaller γ the rapid increase of light emission without successors indicates a breakdown mechanism by streamer formation.

537.52

2331 A STEPWISE INCREASE IN THE ELECTRON CURRENT TO A PROBE PLACED IN A DISCHARGE IN A MAGNETIC FIELD. A.V.Zharinov.
Atomnaya Energiya, Vol. 7, No. 3, 215-19 (1959). In Russian.

Preliminary results from a study of the effect of a magnetic field on electron diffusion in a plasma are described. A stepwise increase in the ratio of the electron current at a probe to the ion current has been found for a certain critical magnetic field strength. According to the preliminary results, this critical magnetic field is proportional to the gas pressure. These facts seem to indicate that there are two qualitatively different mechanisms of the transverse movement of electrons, one of these being diffusion by collisions. J.B.Sykes

537.52

2332 THE STUDY OF ELECTRICALLY DISCHARGED O_2 BY MEANS OF AN ISOTHERMAL CALORIMETRIC DETECTOR. L.Elias, E.A.Ogryzlo and H.I.Schiff.
Canad. J. Chem., Vol. 37, No. 10, 1680-9 (Oct., 1959).

Molecular oxygen was subjected to an electrodeless discharge in the pressure range 0.1-3 mm Hg. The oxygen atom concentration was measured as a function of time in a flow system by means of a movable atom detector which consisted of a platinum wire coated with a suitable catalyst for atom recombination. The atom concentration was calculated from the heat liberated when the detector was operated under isothermal conditions. The surface recombination was found to be first order in the atom concentration. A value of 7.7×10^{-6} was obtained for the recombination coefficient (γ) on Pyrex. No temperature dependence for γ was observed. The gas phase recombination of oxygen atoms was found to be consistent with the mechanism

$$O + O_2 + M \rightarrow O_3 + M$$
$$O + O_3 \rightarrow 2O_2$$

The rate constant for the third-order reaction was found to have a value of 1.0×10^{14} cm^6 mole^{-2} sec^{-1}, and a small negative temperature dependence. Evidence was also obtained for the presence of considerable amounts of excited molecular oxygen in electrically activated O_2.

537.52

2333 BUILDUP OF A DISCHARGE IN ARGON. M.Menes.
Phys. Rev., Vol.116, No.3, 481-6 (Nov. 1, 1959).

Measurements were made of the rate of buildup of an electrical discharge in argon in the pressure range from 5 to 60 Cm Hg. The results are interpreted on the basis of a secondary mechanism due to delayed photons. The photon delay times which fit the observed data are ~ 5 μsec over the range of pressures investigated. These photon delay times are compared with (a) calculated imprisonment times for resonance radiation, and (b) delay times for molecular radiation as observed by Colli (Abstr. 10287 of 1954). Considering the uncertainty in the calculations and the lack of knowledge about the energy distribution between the two main resonance lines, the imprisonment times are of the right magnitude to explain the observed buildup rates. The Colli-process delay times are in fair agreement with the data at the higher pressures; at the low pressures they are definitely too slow to explain the observed buildup rates.

537.52

2334 THE INFLUENCE OF EXTERNAL ILLUMINATION ON MOVING STRIATIONS IN A DISCHARGE IN NEON. L.Pekárek.
Czech. J. Phys., Vol. 8, No. 6, 742-4 (1958).

The way in which the parameters (such as velocity of propagation, velocity of motion and length of striations) of slow and fast waves of stratification, produced in a neon discharge by pulsing an external electrode, are influenced by intense irradiation from another neon discharge was investigated. The irradiation decreased the amplitude of the slow wave, but increased that of the fast wave; this is taken to support the view that slow waves involve step-wise ionization whereas fast waves involve direct ionization. J.Dutton

537.52

2335 A NOTE ON THE THEORY OF THE SUCCESSIVE PRODUCTION OF MOVING STRIATIONS IN THE PLASMA OF INERT GASES. M.Novák.
Czech. J. Phys., Vol. 9, No. 1, 78-83 (1959). In Russian.

Approximate expressions are derived, on the basis of Pekárek's theory (Abstr. 5645 of 1959), for the period of the maximum t_B of a wave packet produced by the passage of a stratification wave before the aperture of a photomultiplier, and for its time-width in the half-height Δt_B. The relaxation time of a stratification wave can thus be calculated by means of the experimentally measured velocity of motion of the maximum of a wave packet u and its width Δt_B. The calculation is supplemented by numerical data on the magnitude of errors introduced by using approximate expressions.

537.52

2336 EXPERIMENTAL VERIFICATION OF THE THEORY OF THE SUCCESSIVE PRODUCTION OF STRIATIONS IN A GLOW DISCHARGE. L.Pekárek.
Czech. J. Phys., Vol. 9, No. 1, 67-77 (1959).

The properties were measured of the stratification wave in the plasma of the positive column in a glow discharge in neon. The measurements are compared with theoretical results and good agreement is found.

537.52

2337 A CONTRIBUTION TO THE STUDY OF ELECTRODE SPACES OF HIGH-CURRENT SHORT-DURATION ELECTRIC DISCHARGES. V.Hermoch.
Czech. J. Phys., Vol. 9, No. 1, 84-90 (1959). In Russian.

The spaces are analysed using the method of artificial contraction (limiting of the active surface of the electrodes). It is shown that evaporation of the electrodes during the discharge can be regarded as one of the main factors causing thermal contraction of the channel on the surface of electrodes and high-current density on the electrodes, and enabling the independent existence of partial spots.

537.52

2338 THE CHANNEL OF A SHORT-TIME HIGH-INTENSITY ELECTRIC DISCHARGE. V.Hermoch.
Czech. J. Phys., Vol. 9, No. 3, 377-87 (1959). In Russian.

By means of the spatial expansion of the radial cross-section of the channel of a discharge (duration 10^{-8} sec and maximum current less than 10^4 A) and by measuring some of its electrical quantities, information was obtained about the conditions existing in the channel and about the mechanism of its formation.

537.52

2339 THE VAPOUR JETS OF ELECTRODE MATERIAL OF A SHORT-TIME HIGH-CURRENT ELECTRIC DISCHARGE. V.Hermoch.
Czech. J. Phys., Vol. 9, No. 2, 221-6 (1959). In Russian.

The velocity of vapours from electrodes and the values of the electric gradient of the channel were measured. An explanation is given of the dependence of the discharge rate of the vapours on the electrode material and the thermal origin of the jets is confirmed. The validity of the results is shown for the case of a different experimental arrangement, or the formation of other types of discharge on electrodes.

537.52

2340 A SPARK GAP FOR VERY HIGH GAS PRESSURES. G.List.
Exper. Tech. der Phys., Vol. 7, No. 3, 118-25 (1959). In German.

Describes, with detailed drawings, a spark gap and associated compression equipment for use at pressures of up to about 1000 atm. Some breakdown voltage data for N_2 and Ne–He are given for maximum pressure × gap length of about 600 atm mm. J.D.Craggs

537.52

2341 SOME NEW RESULTS IN THE STUDY OF LONG SPARKS. I.S.Stekol'nikov.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 23, No. 8, 975-9 (1959). In Russian.

The mechanism of spark discharges between electrodes of simple shapes is investigated electrically and photographically. The dependence of corona on the form of the applied voltage is studied, and the development of the "leader" stage is related to the resistance and capacity of the circuit. Reasons underlying the differences between results obtained in various laboratories are suggested. A.E.I. Research Laboratory

537.52

2342 ON WALL STABILIZED HIGH PRESSURE LONG ARCS IN XENON AT LOWER PRESSURES AND SMALL THERMAL WALL LOSSES. H.Schirmer.

Z. Phys., Vol. 156, No. 1, 55-65 (1959). In German.

If the current strength is high enough, low pressure arcs approximate in equilibrium conditions etc. to normal "high pressure" arcs. The properties of such arcs in xenon are discussed and outlined. Radial temperature variations and light emission for currents varying up to 400 A are discussed. J.D.Craggs

537.52 : 621.791.753.9

2343 THE APPLICATION OF THE THERMODYNAMICS OF IRREVERSIBLE PROCESSES TO WELDING ARCS. E.F.Holländer.
Czech. J. Phys., Vol. 9, No. 2, 229-36 (1959).

The self-regulation of an inert-gas-shielded metal welding arc is dealt with briefly. A thermodynamic equation is derived for the self-regulation of such an arc.

537.52

2344 ON THE POSSIBILITY OF CONTROL OF NON-UNIFORMITY OF ENTRY OF ALLOYS INTO THE GASEOUS CLOUD OF AN ARC BY USING THE SPECTRUM OF THE BASIC ALLOY COMPONENT. N.K.Rudnevskii.
Optika i Spektrosk., Vol. 4, No. 3, 296-300 (1958). In Russian.
English summary: PB 141047T-4 obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The non-uniformity of the entry of simple alloys into the gaseous arc cloud is investigated for Cu–Ni, Cu–Mn, and Cu–Zn alloys over a wide range of alloy composition. It is claimed that deductions on the nature of entry of copper into the arc cloud may be made from the results. G.I.W.Llewelyn

537.52

2345 RECOMBINATION IN XENON AND KRYPTON AFTERGLOWS. J.J.Lennon and M.C.Sexton.
J. Electronics and Control, Vol. 7, No. 2, 123-32 (Aug., 1959).

Electron density decay was studied in the afterglow of pulsed electrodeless microwave discharges in krypton and xenon using 3 cm equipment. Each gas contained an unknown impurity of not more than 0.5% of the other. Gas pressure was varied from 3 to 30 mm Hg and ionizing pulse power from 1.5 to 22.5 kW. The xenon afterglow was unaffected by the krypton impurity at pressures above 5 mm Hg and led to a recombination coefficient of 2.3×10^{-6} cm^3/ion sec at 10 mm Hg. This coefficient increased with pressure above 10 mm Hg, probably caused by pressure limitations on the microwave method. It is suggested that the krypton afterglow was greatly affected by charge transfer to the xenon impurity. A recombination coefficient of not greater than 1.1×10^{-6} cm^3/ion sec is deduced for krypton.

537.52 : 551.5

2346 INVESTIGATION OF AURORAL AFTERGLOW AND ITS PREPARATORY STAGES. I. PREPARATION OF THE DISCHARGE TUBE AND MEASURING APPARATUS. H.H.Brömer.
Z. Phys., Vol. 157, No. 5, 601-12 (1960). In German.

A special apparatus has been developed in order to produce an auroral afterglow and to measure the decay of light intensity of some afterglow emissions over several powers of ten. The preparation of different discharge tubes during which the air, the nitric oxide, and Lewis–Rayleigh afterglow appear also is described. The corresponding spectra are given.

537.52 : 551.5

2347 INVESTIGATION OF AURORAL AFTERGLOW AND ITS PREPARATORY STAGES. II. DECAY OF THE AFTERGLOW IN THE AIR-GLOW, NO AND LEWIS–RAYLEIGH STAGES. H.H.Brömer.
Z. Phys., Vol. 158, No. 1, 1-11 (1960). In German.

The decay of the continuum of the air afterglow was found to be equal in the whole spectral range used. At the beginning of the afterglow [NO] is not constant. N atoms from the discharge create O atoms by reacting with NO and retard the intensity decay. Later [NO] remains constant during the afterglow. The decay curves measured in the nitric oxide and the Lewis–Rayleigh stage agree with current theories of recombination of N_2 and NO by three-body collision. If the spectral intensity distribution in the Lewis–Rayleigh afterglow is due to the action of different third bodies, as Reinecke (1953) suggested, then this model is to be improved by accepting a two step reaction. The measurements can be interpreted, if the first step is responsible for the rate, and the second for the intensity distribution. No evidence could be found for the Cario–Kaplan processes to be more frequent in the neighbourhood of the exciting discharge than that of recombination. On the other hand,it could be shown that the recombination of N atoms is severely hindered by transition into the auroral stage and additional collision processes become effective in the excitation of all transitions of the first positive group.

537.52

2348 EXCITATION TEMPERATURE MEASUREMENTS IN GLOW AND ARC DISCHARGES IN HYDROGEN.
H.Edels and W.A.Gambling.
Proc. Roy. Soc. A, Vol. 249, 225-36 (Jan. 1, 1959).

Experiments on high-pressure glow discharges in hydrogen (Gambling and Edels, Abstr. 433 of 1957) have shown that columnar glow to arc transition could be induced or reversed by control of the thermal conditions of the discharge, indicating that the transition depends upon the discharge temperature values. The relative intensities of the α, β and γ Balmer lines emitted by the discharge column section were measured and the variation of the excitation temperatures $T_{\alpha\beta}$ and $T_{\beta\gamma}$ through the discharge transition region derived, using a photomultiplier technique which yielded derived temperature values accurate to ±3% for currents between 0.25 and 10 A and for pressures from 0.33 to 2 atm. The results show that with current variation the excitation temperature curves always exhibit minima at the transition current, constant at 3900 ± 100° K for $T_{\alpha\beta}$ and 2800 ± 100° K for $T_{\beta\gamma}$. The results indicate a thermally dependent mechanism of arc column formation in hydrogen and show that when the column is in the glow state $T_{\alpha\beta} > T_{\beta\gamma}$. Above the transition current value the results show that the excitation temperatures rapidly converge, so that for the arc a thermal distribution of concentrations exists in the quantum states n = 3, 4, and 5. However, from considerations of the derived values of electron drift velocity and from calculations of the excess of the electron temperature over the gas temperature, despite the equality of $T_{\alpha\beta}$ and $T_{\beta\gamma}$, true thermal equilibrium is concluded not to exist in the newly formed low-current arc column in hydrogen. The transition in the column from glow to arc is explained in terms of the change in effective thermal conductivity produced by the variations of dissociation with temperature.

537.52 : 535.33 : 539.19

SPECTRUM OF A GLOW DISCHARGE IN NITROGEN–HYDROGEN MIXTURES AT HIGH PRESSURES. See Abstr. 1520

537.52 : 537.533

CATHODE FALL IN THE GLOW DISCHARGES IN INERT GASES. See Abstr. 1153

537.52

2349 CARRIER MULTIPLICATION OF AN AVALANCHE WITH INTRINSIC SPACE CHARGE. K.Richter.
Z. Phys., Vol. 157, No. 1, 130-3 (1959). In German.

From oscillograms of avalanches of high amplification (ether, p = 370 torr, d = 0.3 cm, E/p = 77), one can deduce that the number of carriers (n) increases at a rate less than $e^{\alpha x}$, if $n > 10^6$. It is the space charge field of the positive ions which reduces the ionization effect of electrons.

537.52 : 621.387

2350 A STUDY OF ANODE OSCILLATIONS IN A LOW PRESSURE DISCHARGE. A.A.Zaitsev and K.I.Éfendiev.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 23, No. 8, 1012-16 (1959). In Russian.

This study has been carried out in connection with the development of noise sources for use in test equipment and also as a general means of furthering knowledge about discharge processes. Three types of anode have been used: a divided electrode consisting of three separate parts of similar size; a rod; and a half cylinder. The discharge current varied between the limits 0.1 to 7.0 A. The pressure of the mercury vapour was controlled by a water bath. It was found that when regular oscillations took place the anode voltage drop was always higher than the exciting potential of Hg atoms. Motion of the cathode spot, while it did not destroy the form and stability of the anode oscillations, gave rise to separate irregular oscillations superposed upon the anode oscillations. When the vapour pressure was reduced and the discharge current increased, the amplitude of the oscillations and the average value of the voltage drop increased. The frequency of the oscillations lay between 10^4 and 10^5 c/s. Studies were also made in inert gases (He, Ne, Ar, Kr) on pressures below 10^{-3} and 1 mm Hg and at discharge currents up to 300 mA. When the anode dimensions were decreased the amplitude and frequency of the oscillations increased. At a fixed pressure,

current and anode size, the relationship between atomic weight and frequency was regular and reciprocal. A simple explanation is given of the facts in terms of a second, moving plasma in a dynamic condition. S.C.Dunn

537.52

2351 THE APPEARANCE OF POLYATOMIC CARBON MOLECULES IN THE HIGH FREQUENCY SPARK BETWEEN GRAPHITE ELECTRODES.
E.Dörnenburg and H.Hintenberger.
Z.Naturforsch., Vol.14a, No.8, 765-7 (Aug., 1959). In German.

Photographic recording of the mass spectrum of graphite which has been volatilized and ionized in a high frequency spark has revealed, in the mass range from 36 to 360, lines of C_3^+, C_4^+, C_5^+,..., C_{30}^+. Their sharp lines in the mass spectrum are accompanied by broad diffuse lines which must be ascribed to ions that have suffered a decay on their passage from the electric to the magnetic field, i.e. within 10^{-9} sec. Up to C_9 there seems to be a preponderance of ions with odd numbers of C-atoms. Beginning with 10 C-atoms two strong lines have been noticed with a periodicity of 4 C-atoms. They belong to the ions with 10 and 11, 14 and 15, 18 and 19,...C-atoms and are followed in turn by two lines of decreasing intensity from 12 and 13, 16 and 17,...C-atoms. Doubly charged ions C_n^{++} have also been observed. The intensities have been measured electrometrically. R.Schnurmann

537.52

2352 MEASUREMENT OF THE ELECTRIC FIELD IN A VERY HIGH-FREQUENCY PLASMA.
V.E.Mitsuk, M.D.Koz'Minÿkh and I.V.Talalaeva.
Izv. Akad. Nauk SSSR, Ser fiz, Vol. 23, No. 8, 1031-5 (1959). In Russian.

The method proposed depends on the Stark splitting of the spectrum of H. The high-frequency field variation imposes a "fine structure" on the ordinary Stark effect; as a measure of the amount of Stark splitting, the authors use the half-width of the envelope of the intensities of the observed collection of lines. An experiment testing the method shows that, for a steady state, the half-width is proportional to the electric field and may be measured either photographically or with a photomultiplier. The method can also be applied to measure the time variation of the electric field in a pulsed discharge, using a switching circuit and some other techniques described here. O.Penrose

537.52

2353 THE EFFECT OF THE TEMPERATURE OF AN AUXILIARY ELECTRODE ON THE IGNITION OF A HIGH-FREQUENCY DISCHARGE IN HELIUM. Kh.A.Dzherpetov.
Izv. Akad. Nauk SSSR, Ser fiz., Vol. 23, No. 8, 1036-9 (1959).
In Russian.

On increasing the auxiliary electrode temperature, the breakdown strength remains constant at first, then it decreases rapidly over a certain range of temperatures, and then it again becomes practically constant. At different temperatures of the auxiliary electrode, the dependence of the breakdown strength on pressure has two minima. Above a certain electrode temperature, the region of maximum values of breakdown strength between the two minima is shifted to lower pressures. The effects are due to changes in the initial concentration of electrons in the discharge gap. Z.Krasucki

537.52 : 621.372.413

2354 THE EFFECT OF FIELD CONFIGURATION ON GAS DISCHARGE BREAKDOWN IN MICROWAVE CAVITIES AT LOW PRESSURE. S.A.Self and H.A.H.Boot.
J. Electronics and Control, Vol. 6, No. 6, 527-47 (June, 1959).

A new regime of high-frequency gas discharge breakdown in nonuniform fields at low pressures is predicted on theoretical grounds and experimentally confirmed. The controlling mechanism is the time-averaged Lorentz force on the electrons, proportional to the gradient of the square of the electric field amplitude ($\nabla|E|^2$). This steady force is derivable from a potential, and field configurations are realizable in microwave cavities corresponding to potential hills or wells, exemplified by E_{010} and E_{011} cylindrical cavities respectively. In the former case the steady force acts to disperse electrons towards the walls, increasing the loss of electrons and raising the breakdown field, whereas in the latter case the steady force acts to confine electrons, inhibiting electron loss and lowering the breakdown field. The effect becomes marked at levels of field intensity for which the height of the potential hill or well becomes comparable with the ionization energy. Breakdown fields have been measured for hydrogen in E_{010} and E_{011} X-band cavities in the pressure range 30 mm Hg to 7×10^{-3} mm Hg. The peak breakdown fields range from 400 to 30 000 V/cm. At the higher pressures and lower fields the results are in agreement with the diffusion theory. However, at the lower pressures and higher fields the behaviour of the two cavities is markedly different and qualitatively confirms the controlling effect of the time-averaged Lorentz force.

537.52

2355 DEPENDENCE OF THE BREAKDOWN FIELD OF CdS SINGLE CRYSTALS ON THEIR INTERNAL STRUCTURE.
K.W.Böer, U.Klimmel and G.Ksoll.
Z. phys. Chem. (Leipzig), Vol. 210, No. 3-4, 128-35 (March, 1959).
In German.

The breakdown voltage was changed by a factor of 50 by annealing treatments in vacuum and in oxygen. The term spectrum above the Fermi level was examined by conductivity glow curves and found to have no appreciable effect on the breakdown process. B.T.M.Willis

537.52

2356 ON THE STATISTICS OF IGNITION DELAY [TIME LAG]. H.Sohst.
Z. Phys., Vol. 154, No. 5, 618-32 (1959). In German.

Experimental determinations of the time lag of breakdown in N_2 (pd = 1000 mm Hg cm and over-voltages from 1 to 5%) and H_2 (pd = 400 mm Hg cm and over-voltages from 1 to 3%) for various values of the initial current from the cathode (within the range 5×10^5 to 10^9 electrons/sec) are described. The graphs of $\ln(n_t/n_0)$ versus t (n_t/n_0 is the fraction of the total lags with duration greater than t) thus obtained are straight lines for low initial currents but are curved for higher values. This is ascribed to the relative increase in importance of the statistics of the processes giving rise to the growth of current with respect to the statistics of the emission of initial electrons, as the rate of production of initial electrons increases. J.Dutton

PLASMA

537.56

2357 GENERAL THEORY OF PLASMA. V.Ferraro.
Nuovo Cimento Suppl., Vol. 13, No. 1, 9-58 (1959).

A concise account is given of the physics of ionized gases according to the kinetic theory. Consideration is given to the effects of collisions, electric and magnetic fields, thermal conductivity, and the propagation of electrostatic, electromagnetic and hydromagnetic waves. A.H.Gabriel

537.56

2358 PLASMA PHYSICS ON COSMICAL AND LABORATORY SCALE. B.Lehnert.
Nuovo Cimento Suppl., Vol. 13, No. 1, 59-110 (1959).

The behaviour of a partially ionized plasma is derived using dimensionless parameters, each property being related to phenomena on a laboratory scale and in the upper atmosphere. Consideration is given particularly to the damping of magnetohydrodynamic waves. Two experimental illustrations are given. The first is the propagation of torsional oscillations in a magnetohydrodynamic waveguide. It is shown that Alfvén waves can exist in an ionized gas in the laboratory only in a high current discharge of large dimensions. The second example is the diffusion to the walls of a plasma column in a longitudinal magnetic field. A sudden increase in this diffusion at a critical value of the field supports an earlier theory based on the production of transverse electric fields. A.H.Gabriel

537.56

2359 HIGH TEMPERATURE PLASMAS. P.C.Thonemann.
Nuovo Cimento Suppl., Vol. 13, No. 1, 111-31 (1959).

A survey is given of diagnostic techniques for use on laboratory scale plasmas, with particular reference to their use with Zeta. The discussion following raises several interesting points concerning the functioning of Zeta. A.H.Gabriel

537.56 : 537.3

HIGH-POWER PULSE STEEPENING FOR THE PRODUCTION OF HIGH TEMPERATURE GASEOUS PLASMAS. See Abstr. 2310

537.56

2360 MICROWAVES IN AN IONIZED GAS. A.Gilardini.
Nuovo Cimento Suppl., Vol. 13, No. 1, 132-65 (1959).

The advantages of using microwaves both for the production and diagnostics of plasmas are outlined. The basic formula for the complex conductivity of a plasma is derived, and thence expressions for the energy gain, distribution function, ionization and excitation rates. The microwave breakdown condition is found both with and without a d.c. magnetic field, and this gives a good agreement with experiment. The sustained microwave discharge is considered. Measurements of electron density and collision frequency are discussed.

A.H.Gabriel

537.56 : 538.3

OSCILLATIONS IN THE B-1 STELLARATOR. See Abstr. 1192

537.56

2361 STELLAR PLASMA. E.Schatzman.
Nuovo Cimento Suppl., Vol. 13, No. 1, 166-88 (1959). In French.

The stellar gas is considered as in thermodynamic equilibrium, with energy states populated according to Boltzmann and Maxwell distributions and the Saha equation. Degeneracy of the electron gas at high densities is considered, and also those regions in which collective phenomena are important. It is shown that electron space charge surrounding ions will increase thermonuclear reaction rates by diminishing Coulomb repulsion. The methods by which the reaction energy is given up by the high energy reaction products to the electron and ion gases are considered in detail, in particular, ways in which differences in temperature between electrons and ions could be produced.

A.H.Gabriel

537.56

2362 A STATISTICAL DESCRIPTION OF FULLY IONIZED PLASMAS. H.J.Kaeppeler.
Z. Naturforsch., Vol. 14a, No. 12, 1056-69 (Dec., 1959). In German.

A very detailed and basic theoretical treatment of the statistics of completely ionized plasmas involving, for example, a study of the generalized transport equation (Maxwell's equation), etc.

J.D.Craggs

537.56

2363 SCATTERING POTENTIAL IN FULLY IONIZED GASES. O.Theimer and R.Gentry.
Phys. Rev., Vol. 116, No. 4, 787-92 (Nov. 15, 1959).

Recent methods for calculating the probability W(E)dE that a test particle in a plasma experiences an electrical field of magnitude $E \pm \frac{1}{2}dE$ are discussed. In particular, the assumption is analysed that the distribution W(E) in a system of true charges can be calculated from an auxiliary system of uncorrelated virtual particles which, formally, do not interact although they are the sources of shielded Coulomb fields of the type introduced by Debye and Hückel. It is shown that the electrostatic energy of the auxiliary system, calculated as a volume integral over the average energy–density $\langle E^2 \rangle_{AV}/8\pi$, is identical with the interaction energy of the true particles as obtained by Debye–Hückel theory. The distribution of the micropotential $W(\Psi)d\Psi$ in a plasma is also calculated from the auxiliary system and used for deducing a scattering potential $\Psi(r)$ which has a natural cutoff at a distance equal to the average distance between neighbouring ions. An approximate analytical expression for $\Psi(r)$ is given and the physical nature of the scattering potential is discussed.

537.56

2364 DISCHARGE PHENOMENA IN LORENTZ PLASMAS. STUDY OF THE ELECTRON DISTRIBUTION IN THE PRESENCE OF A MAGNETIC FIELD. P.Maroni.
C.R. Acad. Sci. (Paris), Vol. 249, No. 8, 881-3 (Aug. 24, 1959). In French.

Integrates — by separation of the variables — the partial differential equation for the electron distribution function, given by Jancel and Kahan (Abstr. 9214 of 1957) for the case of hydrogen.

B.Meltzer

537.56

2365 DISCHARGE PHENOMENA IN LORENTZ PLASMAS. STUDY OF THE ELECTRON DISTRIBUTION IN THE MAGNETIC FIELD. P.Maroni.
C.R. Acad. Sci. (Paris), Vol. 249, No. 9, 914-16 (Aug. 16, 1959). In French.

Sequel to the preceding abstract. Treats the more special cases of Jancel and Kahan's equation for the electron distribution function.

B.Meltzer

537.56 : 538.56

2366 ON THE DAMPING OF ELECTROMAGNETIC WAVES IN A PLASMA SITUATED IN A MAGNETIC FIELD. K.N.Stepanov.
Zh. eksper. teor. Fiz., Vol.35, No.1(7),283-4 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol.35(8), No.1, 195-6 (Jan. 1959).

A brief theoretical study of the damping of e.m. waves in a completely ionized plasma at high temperatures and low plasma densities.

J.D.Craggs

537.56 : 538.3

2367 HYDRODYNAMIC ANALYSIS OF THE COMPRESSION OF A RAREFIED PLASMA IN AN AXIALLY-SYMMETRIC MAGNETIC FIELD. Yu.N.Barabanenkov.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1280-1 (Nov., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 893-4 (May, 1959).

Treats the motion of a collision-free plasma near the axis of symmetry of the magnetic field. The equations of Chew, Goldberger, and Low for the guiding centre approximation (Abstr. 6794 of 1956) are solved for two special cases: (i) an axial field $H_z = \text{const.} \exp(z^2/2a^2)$ is suddenly switched on, and the plasma undergoes oscillatory longitudinal compression; (ii) a periodic field $H_z = H_1(t) - H_2(t)\cos(\pi z/a)$, with $H_1 > H_2$ and $H_2(o) = 0$, is applied quasi-statically and the plasma forms bunches concentrated near the minima of H_z.

O.Penrose

537.56

2368 THE TRANSPORT PHENOMENA IN CYLINDRICAL DISCHARGES IN THE PRESENCE OF MAGNETIC FIELDS. J.Friedrich, H.Schirmer and I.Stober.
Z. Naturforsch., Vol. 14a, No. 12, 1047-56 (Dec., 1959). In German.

Gives a comprehensive theory of transport phenomena in plasmas, involving the self magnetic field in the presence of a longitudinal magnetic field, to a second order of approximation. Considering either the self or longitudinal field alone, a general expression can be obtained to the n-th order of approximation.

J.D.Craggs

537.56

2369 WAVES OF CHARGE-DENSITY OSCILLATIONS IN A CYLINDRICAL PLASMA.
M.Ya.Vasil'eva, A.A.Zaitsev and É.D.Andryukhina.
Izv. Akad. Nauk SSSR, Ser fiz, Vol. 23, No. 8, 995-8 (1959). In Russian.

An experimental investigation of electroacoustic waves (positive-ion oscillations) in the positive column of a He discharge. The waves were observed at pressures below about 0.01 mm Hg at a current of 30 mA in a tube of radius 1.5 cm. Their phase velocity, calculated from their wavelength and the frequency of the electric field used to excite them, was of order 30000 m/sec and independent of frequency; the value of $(kT_e/m_i)^{\frac{1}{2}}$ was 20000 m/sec. At pressures in the range from 0.07 to 0.7 mm Hg, a different, strongly dispersive, type of wave ("moving striations") was observed. Similar results were obtained for A and Kr, except that the electroacoustic waves required lower pressures (0.003 mm Hg) and were damped.

O.Penrose

537.56

2370 INCOHERENT MICROWAVE RADIATION FROM PLASMAS. G.Bekefi, J.L.Hirshfield and S.C.Brown.
Phys. Rev., Vol. 116, No. 5, 1051-6 (Dec. 1, 1959).

A study is made of the incoherent radiation from an isotropic, quiescent plasma of a low degree of ionization. Three cases are treated theoretically: the transparent plasma, the semiopaque plasma, and the opaque plasma. Radiation from positive columns of d.c. glow discharges in helium and hydrogen for the three cases treated theoretically are studied experimentally at 3000 Mc/s, and good agreement is obtained between theory and experiment.

537.56 : 539.12

OCCURRENCE OF CHERENKOV RADIATION IN A HIGH-TEMPERATURE PLASMA. See Abstr. 1268

537.56

2371 HEAT TRANSFER RATES OF AN ARGON PLASMA JET. C.S.Stokes, W.W.Knipe and L.A.Streng.
J. Electrochem. Soc., Vol. 107, No. 1, 35-8 (Jan., 1960).

Heat flux measurements were made. Experimental values as high as 4.5 kcal/cm² sec were obtained for the transient-heating rate of a small copper slug. The heat-flux variation with energy supplied and the energy distribution to cathode, anode, and plasma are presented.

537.56

2372 A STUDY OF THE RELATIVE IMPORTANCE OF ANISOTROPIC DISTURBANCES IN A WEAKLY PERTURBED PLASMA. J.L.Delcroix and D.Quemada.
C.R. Acad. Sci. (Paris), Vol. 249, No. 12, 1039-41 (Sept. 21, 1959). In French.

A brief theoretical note discussing the effect on the electron energy distribution of various perturbations, interaction effects etc. The effect of the electric field in the discharge is considered.

J.D.Craggs

537.56 : 539.18

STARK BROADENING OF HYDROGEN LINES IN A PLASMA. See Abstr. 1480

ELECTRON EMISSION
ELECTRON BEAMS

537.533

2373 WORK FUNCTION OF IRON SURFACES PRODUCED BY CLEAVAGE IN VACUUM. R.E.Simon.
Phys. Rev., Vol.116, No.3, 613-17 (Nov. 1, 1959).

Kelvin measurements of the contact potential difference between iron surfaces prepared by cleavage in high vacuum and freshly flashed tungsten surfaces are reported. From these measurements, the work function of iron could be found since the work function of the tungsten was known. The work function of the cleavage plane of iron was 4.17 ± 0.03 eV at liquid nitrogen temperature. Evidence indicating that these measurements were made on clean surfaces is presented. The work function determined is believed to be that of the (100) plane of iron.

537.533

2374 DISCRETE ENERGY LOSSES OF ELECTRONS IN SOLIDS AND YIELD OF SECONDARY ELECTRONS. N.B.Gornyĭ.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 281-3 (July, 1958). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 35(8), No. 1, 193-5 (Jan., 1959).

The discrete energy losses $V_p - V_k$ of incident and reflected electrons in a number of semiconductors and dielectrics are compared with the corresponding work functions $e\phi$ and the maximum secondary emission coefficients δ_{max}. The results lead to the conclusions that (a) substances for which all values of $V_p - V_k$ are greater than $e\phi$ have a large δ_{max} (MgO, CaO, BaO, NaCl, KCl) and (b) substances for which the highest values of $V_p - V_k$ have values less than $e\phi$ have a low δ_{max} (Ge, MoO_2). Cu_2O, GeO_2 and BeO are placed in an intermediate class. The classification is explained by a consideration of the energetics of the possible processes, of which inter-band transitions are most important.

C.H.B.Mee

537.533

2375 THE EXO-ELECTRON EMISSION (KRAMER EFFECT) OF ZnO. R.Menold.
Z. Phys., Vol. 157, No. 4, 499-509 (1960). In German.

The emission glow curves of single crystals and of pure and doped powders, after stimulation by X-rays, were measured by means of a G.M. counter. Maxima were found at 135°, 192° and 260° C. Conductivity glow-curves of single crystals and films, which were also measured, showed no maximum between 20° and 280° C. The experiments show that the emission of exo-electrons cannot be a consequence of an enrichment of electrons (Maxwell-tail) in the conduction band set free from metastable states in the forbidden gap of ZnO during the heating of the specimen. Theoretical considerations lead to the same conclusion. Further is could be shown, that the emission phenomenon cannot be explained by recombination processes in the depletion layer, if the present knowledge of the ZnO band model is correct. It is assumed that the emission maxima are due to centres in the sorption layer.

537.533 : 539.2 : 537.311

2376 ELECTRON EMISSION FROM SILICON p—n JUNCTIONS. B.Senitzky.
Phys. Rev., Vol. 116, No. 4, 874-9 (Nov. 15, 1959).

Electron emission from uncoated, reverse biased, silicon p—n junctions was investigated. A junction with a 1 cm diameter and a reverse bias of 0.1 A gives rise to an emission current, around its perimeter, of the order of 10^{-13} A. The emission commences at fields which are considerably lower than those required for breakdown and is dependent on the junction bias conditions as well as the lattice temperature. The degree of dependence on the lattice temperature is a function of the bias conditions. A simple mechanism is proposed to explain these phenomena.

537.533

2377 ANOMALOUS THERMIONIC EMISSION OF SOME BORIDES AND CARBIDES OF RARE EARTH AND TRANSITION ELEMENTS. E.A.Kmetko.
Phys. Rev., Vol. 116, No. 4, 895-6 (Nov. 15, 1959).

Thermionic emission constants, A*, up to several thousand times larger than the A_o (120 amp/cm² - °K²) predicted theoretically for metals have been reported for several compounds involving transition metals and rare earths with boron and carbon. It is suggested that such anomalously large emission constants, as well as some anomalously small ones, are due to the relatively large distances between metal atoms as a result of which the energy bands originating from the incomplete atomic f and/or d sublevels are narrow enough for nondegeneracy to occur in the experimental temperature range.

537.533 : 537.54

2378 USE OF OXIDE-COATED CATHODES IN HIGH CURRENT ELECTRON ACCELERATORS. G.Davidson, S.Ozaki and R.Weinstein.
Rev. sci. Instrum., Vol. 31, No. 1, 31-2 (Jan., 1960).

An oxide-coated cathode (modified Sperry button type) was used as an electron source for the M.I.T. 320 MeV electron synchrotron. With this new cathode, an average lifetime of 330 hr was obtained, operated at peak-pulsed current of 200 mA in vacua as poor as about 10^{-5} mm Hg. This represents a factor of about 20 improvement in lifetime-current product over directly heated cathodes.

537.533

2379 WILL PHOTOELECTRONS FROM MAGNETIC METALS BE POLARIZED?. E.S.Dayhoff.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 234S-235S (April, 1959).

Photoelectrons obtained from magnetic metals are expected to show a magnetic polarization or spin alignment under favourable conditions. Arguments are given for expecting the degree of alignment to be much greater than that characterizing the average d-shell electron in the metal when the light has a wavelength near the threshold. Furthermore the orientation of the photoelectrons may be either with or against the magnetization of the metal depending upon details of its band structure. A discussion is given of depolarization by scattering in the metal which appears to be insignificant. It is concluded that a high degree of polarization (perhaps greater than 50%) is possible with favourable metals.

537.533 : 539.2

STRUCTURE IN THE ENERGY DISTRIBUTION OF PHOTOELECTRONS FROM K_2Sb AND Cs_2Sb. See Abstr. 1544

537.533

2380 EFFECT OF TEMPERATURE ON PHOTOMULTIPLIERS. M.Lontie-Bailliez and A.Meessen.
Ann. Soc. Sci. Bruxelles I, Vol. 73, No. 3, 390-402 (1959). In French.

The temperature dependence of photocathode and dynode efficiency was measured separately at 6000, 5500, 5000 and 4500 A. Combining these with other published data, a curve was established for the wavelength dependence of the $SbCs_3$ photocathode temperature coefficient, from 2500 to 7000 A. This coefficient changes sign at 5500 A. It is of the order of −0.25% per deg C for $\lambda \leq 5000$ A, but rises sharply for $\lambda \geq 5500$ A. The dynodes always have a negative temperature coefficient, fluctuating around −0.40% per deg C.

This fact can be understood by the decrease of surface charges when the temperature of the semiconductor rises.

537.533 : 539.1.07

2381 THE LOCAL SENSITIVITY OF PHOTOMULTIPLIER PHOTOCATHODES. J.Skřivánek and M.Kuzmiak.

Czech. J. Phys., Vol. 9, No. 1, 112-17 (1959). In Russian.

The influence of the non-uniform distribution of the sensitivity on the spectrum shape of the output pulses from a scintillation detector is studied. Methods of scanning the local sensitivity and determining its distribution function are described. The theory was compared qualitatively with measurements on a slow-neutron detector using a mixture of zinc sulphate and boric acid.

537.533

2382 INVESTIGATION OF THE SECONDARY ELECTRON EMISSION OF ALKALI HALIDE MONOCRYSTALS FOR LOW-ENERGY PRIMARY ELECTRONS.

S.A.Fridrikhov and A.R.Schul'man.

Fiz. tverdogo Tela, Vol. 1, No. 8, 1268-71 (Aug., 1959). In Russian.

The secondary electron emission coefficient of certain alkali halide monocrystals increases as the width of the "forbidden zone" diminishes. Two kinds of fine structure occur in the curve relating the secondary emission coefficient to the energy of the primary electrons. A.E.I. Research Laboratory

537.533

2383 CONTRIBUTION TO EXO-ELECTRON EMISSION FROM CRYSTALS AND METALS. A.Vogel.

Z. Phys., Vol. 158, No. 1, 77-84 (1960). In German.

Decay of the exo-emission during the first few microseconds after the end of excitation and the total number of exo-electrons emitted were measured. Electron-bombarded $CaSO_4$:Mn shows saturation effects; the layer depth efficient for emission of exo-electrons and secondary electrons is discussed. Fatigue of secondary emission occurs in the case of Ag–Mn and Cu–Be. Glow curves of exo-electron emission of these alloys, of MgO, BeO, and the oxides of Zn, Cu(I), Cu(II), Fe(II), Fe(III) are compared.

537.533

2384 THEORY OF ION-ELECTRON EMISSION FROM METALS. II. COMPARISON WITH EXPERIMENT. S.V.Izmailov.

Zh. tekh. Fiz., Vol. 28, No. 10, 2209-16 (1958). In Russian.

In the first part of this work Izmailov postulated a so-called "radiation" mechanism of kinetic ejection of electrons from metals by positive ions, according to which electrons are ejected by an electromagnetic field generated when the ions decelerate rapidly as a result of their collision with the surface atoms of the target, and derived a formula for the coefficient of the kinetic ion-electron emission. It is shown that this formula is in good agreement with the experimental results obtained by other workers e.g. Eremeev and Shestukhina (ibid., Vol. 22, 1262, 1952), or Flaks (ibid., Vol. 25, 2463 and 2467, 1955). However, it is admitted that a more detailed experimental investigation of the secondary-electron emission would be necessary fully to prove the validity of Izmailov's theory, and to enable its further development. M.H.Sloboda

537.533 : 621.385.833

2385 COMMENTS ON A PAPER BY D.H.TREVENA ENTITLED "ON SPACE CHARGE WAVES". R.H.C.Newton.

J.Electronics and Control, Vol.6, No.4, 321-3 (April, 1959).

Considers disagreement between the authors' results (Abstr. 460 B of 1959; Proc. Instn Elect. Engrs, Paper 2780 R, publ. 1958 Part B, Suppl. No.11, 642-4) on "magnetic" space charge wave anodes in a cylindrical electron stream from a magnetically shielded cathode, and those of Trevena (Abstr. 3557 of 1959) and others. Attributes it to the latter's neglect of the perturbation of radial electric field off the steady-state trajectory. B.Meltzer

537.533 : 518

2386 PROBABILITY DENSITY MEASUREMENT WITH AN ELECTRODE MOUNTED IN THE FACE OF A CATHODE-RAY TUBE. H.Lien.

Rev. sci. Instrum., Vol. 30, No. 12, 1100-2 (Dec., 1959).

A small electrode mounted inside the face of a cathode-ray tube gives a "window" comparable to its own dimensions when the bias voltages are set so that secondary electron emission current dominates. Under these conditions the device can be used for measurement of probability densities of random signals.

537.533

2387 EQUILIBRIUM STATE OF TOROIDAL ELECTRON BEAM. M.Seidl.

Czech. J. Phys., Vol. 9, No. 6, 721-35 (1959).

Deals with the collective behaviour of electrons which rotate in a betatron-type magnetic field. It has been shown experimentally that there exists strong interaction between the electrons, which leads to the rapid formation of the equilibrium state with characteristic distribution of the charge density in the cross-section of the toroidal beam. The corresponding relaxation time is of the order of 1 μsec. A statistical theory of the equilibrium beam is elaborated. Its main result is that the effective radius of the beam is a function of two parameters, one of which is proportional to the thermal energy of the electrons, and the other to the perveance of the beam. The charge contained in a toroidal beam of given effective cross-section is equal to the product of the charge the beam would contain at zero temperature and a coefficient which is a function of the temperature of the beam. Its value is unity at zero temperature and rapidly decreases with increasing temperature. The cause of cooling of the beam is shown.

537.533 : 621.317.723

2388 LOGARITHMIC CHARACTERISTIC OF TRIODE ELECTROMETER CIRCUITS. S.K.Chao.

Rev. sci. Instrum., Vol.30, No.12, 1087-92 (Dec., 1959).

The triode-connected 5889 electrometer tube was found to be useful as a logarithmic element over a grid current range of 10^{-14} to 10^{-6} A. The relationship of plate current to grid current was carefully studied over a span of three and one-half decades as a function of the plate supply potential, the plate circuit load resistance, and the filament voltage. A circuit was developed for use in an ionization chamber survey instrument. Most 5889 tubes will work in the circuit after a 150 hr ageing period. Overall accuracy of ± 10% of the reading is feasible.

537.534

2389 RELATIVISTIC THEORY OF THE SPHERICAL ELECTROSTATIC ANALYZER. N.Ashby.

Nuclear Instrum. and Methods, Vol.3, No.2, 90-6 (Aug., 1958).

A general relativistic analysis of the properties of spherical electrostatic analysers is presented, and applied to some special cases of interest. An important limitation on the allowable kinetic energies is shown to exist : for energies greater than a certain kinetic energy T_{max}, the spherical analyser is not an effective focusing instrument. Expressions for the velocity and energy dispersions, and for the resolving power, are derived. A special case, in which the central angle of the analyser is greater than $3\pi/2$, an which has desirable focusing properties, is briefly discussed.

537.533

2390 THEORETICAL INVESTIGATION OF THE IMAGING ABERRATIONS IN ELECTRON DIFFRACTION PATTERNS. H.Noven and F.Lenz.

Z. angew. Phys., Vol. 11, No. 10, 375-80 (Oct., 1959). In German.

The third order aberrations are derived in general form for magnetic electron lens systems used for producing electron diffraction patterns. Explicit expressions are obtained for the case of a thin weak lens, assuming a bell-shaped axial variation of the field. They are in disagreement with the expressions obtained by Grümm and Wagner (Abstr. 3819 of 1955) for the same system by a different method. The first order aberrations, which occur when rotational symmetry is disturbed by constructional faults, are also evaluated as integral expressions. V.E.Cosslett

537.533 : 621.385.833

2391 MAGNETIC DEFLECTION FOCUSING. P.A.Sturrock.

J. Electronics and Control, Vol. 7, No. 2, 162-8 (Aug., 1959).

A scheme for focusing sheet beams by means of a periodic configuration of magnetic fields directed transverse to the beam is presented. Discussion of a particular model gives information about stability limits and perveance. This scheme, which lends itself to the incorporation of intense magnetic fields, should be immune to the space-charge instabilities of beams focused in longitudinal fields. The focusing mechanism is such as to produce coupling between the beam and electromagnetic waves of phase velocity exceeding the velocity of light. Application to millimetre-wave tubes is anticipated.

537.533 : 621.385.833

2392 THEORY OF THE FOCUSING OF SHEET BEAMS IN PERIODIC FIELDS. P.A.Sturrock.

J. Electronics and Control, Vol. 7, No. 2, 153-61 (Aug., 1959).

Equations determining the paraxial behaviour of sheet beams in periodic focusing fields are established. Space-charge is taken into account, and its effect upon stability is investigated. It is proved that, if space-charge is neglected, any such focusing system is convergent. A procedure for determining optimum lamellar-flow configurations is set out, and approximate formulae for the perveance of such focusing systems are presented.

537.533

2393 A TELE-FOCUS ELECTRON GUN AND ITS APPLICATIONS. E.B.Bas and F.Gaydou.

Z. angew. Phys., Vol. 11, No. 10, 370-5 (Oct., 1959). In German.

By suitable design, an electron gun with a plane cathode gave a focal spot of 150 μ at 17 cm from the cathode. Target current was 2 mA. An application for this electron gun is a wide-angle dental X-ray set. Radiographs taken with the instrument are shown.

T.Mulvey

537.533

2394 SOME ELECTRON-OPTICAL PROPERTIES OF INDIVIDUAL ELECTRON FILTER LENSES.

L.N.Bykhovskaya and G.V.Der-Shvarts.

Radiotekhnika i Elektronika, Vol. 4, No. 7, 1145-52 (July, 1959). In Russian.

The properties of electrostatic filter lenses developed for use in an electron microscope projector are investigated experimentally and, in one case theoretically, as a function of their structural dimensions, and their practical operating conditions are described. Their practical application is limited by the small field of vision and they possess high chromatic aberrations. D.E.Brown

537.533

2395 DESIGN AND PERFORMANCE OF A THIN MAGNETIC LENS β-RAY SPECTROMETER.

T.D.Nainan, H.G.Deware and A.Mukerji.

Proc. Indian Acad. Sci. A, Vol. 44, No. 3, 111-22 (Sept., 1956).

Construction of a thin magnetic lens β-ray spectrometer is described. A baffle system which takes advantage of the ring focus has been designed on the basis of the calculations of electron trajectories limited to an angle of acceptance of 9-10.5°. The results of the study of the β-ray spectra of Sr^{90}, Y^{90}, Pm^{147}, Tm^{170} are presented.

537.533

2396 INVESTIGATION OF A BETA-RAY SPECTROMETER WITH A TRIANGULAR FIELD. I.Lindgren.

Nuclear Instrum. and Methods, Vol. 3, No. 2, 104-8 (Aug., 1958).

A long lens beta-ray spectrometer with a pure "triangular" field is here investigated theoretically. A point source as well as a disk source is considered. It is shown that the effect of the source width on the resolution is much smaller with this field than with a uniform field. The spherical aberration is rather large, but the maximum luminosity at a given resolution is larger than with a uniform field. The results are in agreement with experiments.

537.533

2397 REFLECTION OF ELECTRONS FROM A HIGH-FREQUENCY POTENTIAL BARRIER. M.A.Miller.

Zh. eksper. teor. Fiz., Vol.35, No.1(7), 299-300 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol.35(8) No.1, 206-7 (Jan., 1959).

Apparatus for the investigation of reflection of electrons from high-frequency barriers is described and some results obtained with it are plotted. Features which under certain circumstances may lead to misinterpretation of the results are noted.

A.E.I.Research Laboratory

537.533

2398 MULTIPLE SCATTERING OF ELECTRONS AT LARGE ANGLES. I. SOLUTIONS FOR AN INFINITE MEDIUM. G.Molière.

Z. Phys., Vol.156, No.3, 318-47 (1959). In German.

It is shown that the solutions of Boltzmann's transport integro-differential equation which depend only on one coordinate have the same general form as those given by Bethe, Rose and Smith (Abstr. 2597 of 1938) for the diffusion differential equation. The mathematical properties of these solutions are studied and a convenient numerical method is developed to calculate the coefficients of a series expansion of the solutions. P.Roman

537.533

2399 THE RANGE OF ELECTRONS AND POSITRONS OF SMALL ENERGY IN COPPER, SILVER AND GOLD.

K.Gubernator and A.Flammersfeld.

Z. Phys., Vol.156, No.2, 179-88 (1959). In German.

The range of 40-160 keV electrons and positrons in copper, silver and gold is measured. In copper the positrons travel less than electrons of the same energy; in silver and gold they travel more (this disagrees with earlier calculations). Linear relationships are found between range and energy, and for all three absorbers the range is found to depend on a simple universal function of atomic number, atomic weight, and initial energy.

537.533

2400 LOSS OF ENERGY OF 25 keV ELECTRONS IN ATOMIC AND MOLECULAR HYDROGEN.

H.Boersch, J.Geiger and H.J.Reich.

Naturwissenschaften, Vol. 46, No. 21, 596-7 (1959). In German.

A stream of electrons was passed through a container filled with hydrogen at temperatures of 20° and 3200° C. At 20° C the loss of energy was due to molecular hydrogen only. At 3200° C a pronounced energy loss occurred at 10.17 ± 0.15 eV due to the presence of the atomic species. W.J.Orville-Thomas

ION EMISSION . ION BEAMS

537.534

2401 MAGNETIC QUADRUPOLE WITH RECTANGULAR APERTURE. L.N.Hand and W.K.H.Panofsky.

Rev. sci. Instrum., Vol. 30, No. 10, 927-30 (Oct., 1959).

A magnetic quadrupole of rectangular aperture, employing current sheets bounded by iron rather than shaped pole faces to establish the field, is described. The performance of a rectangular quadrupole of aperture 4 × 23 in. is reported.

537.534

2402 A MASS SPECTROMETER FOR HIGH VACUUM TECHNIQUE. W.Tretner.

Z. angew. Phys., Vol. 11, No. 10, 395-9, (Oct., 1959). In German.

A "time of flight" mass spectrometer is described with a resolving power of about 20. For pressures greater than 10^{-6} mm of mercury the spectrum can be scanned at mains frequencies. For lower pressures an electron multiplier must be used to increase the spectrometer output. The spectrometer is of the electrostatic type.

T.Mulvey

537.534

2403 A HEAVY-PARTICLE SPECTROMETER. L.Bianchi, E.Cotton and C.Mileikowsky.

Nuclear Instrum. and Methods, Vol.3, No.2, 69-72 (Aug., 1958). In French.

For light nuclei reactions, the energy of the emitted particle depends appreciably on the emission angle; with a double focusing spectrometer using a large entrance angle, this variation can be of several %. An improvement in energy resolution was achieved by using an astigmatic system (n = 0.57) and a variable tilting angle for the exit slit.

537.534

2404 MASS SPECTROGRAPH OF THE PHYSICAL CHEMISTRY INSTITUTE OF THE CZECHOSLOVAK ACADEMY OF SCIENCES. V.Čermán, V.Hanuš and M.Pacák.

Slaboproudy Obzor, Vol.20, No.10, 603-8 (1959). In Czech.

A general description of the instrument is given. Various items of the device were described by the authors in detail in a number of earlier papers (see : Abstr, 642. 1232, 2952 of 1958 and 7343 of 1959). The instrument is of the Nier type and consists of : (1) a high-vacuum tube containing an ion source and ion collector, (2) an electromagnet for the deflection of ions, (3) an auxiliary focusing electromagnet, (4) high-vacuum pumps and gauges, (5) a dosimeter, and (6) electronic equipment. The electronics of the instrument comprises emission stabilizers, an accelerating and focusing voltage source, a voltage stabilizer and current regulator for the electromagnet, an electrometric amplifier and an automatic sensitivity selector. The spectrograph has been used successfully in the analysis of inert gases, the control of the purity of various gases,

the determination of the isotopes in O and N, the study of ions in liquids and the observation of ion-molecule reactions.

R.S.Sidorowicz

537.534 : 533.5

MASS SPECTROMETER LEAK DETECTOR WITH IMPROVED SENSITIVITY. See Abstr. 2191

PARTICLE ACCELERATORS

537.54 : 537.533

USE OF OXIDE-COATED CATHODES IN HIGH CURRENT ELECTRON ACCELERATORS. See Abstr. 2378

537.54 : 621.384.62

2405 NEW ELECTROSTATIC ACCELERATOR. I.Michael, E.D.Berners, F.J.Eppling, D.J.Knecht, L.C.Northcliffe, and R.G.Herb.
Rev. sci Instrum., Vol. 30, No. 10, 855-63 (Oct., 1959).

A new electrostatic accelerator has been constructed and tested. The entire vacuum system including the accelerating tube and ion source is of bakable construction. The accelerating tube, corona tube, and support column are constructed of thin metal disks hard-soldered to alumina ceramic rings and the insulation length of each is 5 ft. Without the accelerating tube the generator has been operated at potentials in excess of 7 MV corresponding to gradients of over 1400 kV/ft. With flat disk molybdenum electrodes usbale voltage was limited to 2.1 MV. When these electrodes were replaced by flat disk steel electrodes having smaller beam apertures and provided with side pumpout holes, the accelerator was operated for short times at potentials in excess of 4MV corresponding to a tube gradient of over 800 kV/ft. There was no evidence of small discharges or electron loading in the tube. During the course of these tests three tube ceramics were cracked—probably by sparking—and it is now difficult to operate the machine at potentials much above 3.5 MV. Voltage division is accomplished by a series of negative point-to-plane corona gaps which are enclosed in a tube. The charging belt is equipped with paper staples which are charged by induction. Accelerator voltage is very stable.

537.54 : 621.384.62 : 621.317.71

2406 EXTERNAL BEAM CURRENT MONITOR FOR LINEAR ACCELERATORS. L.Bess, J.Ovadia and J.Valassis.
Rev. sci. Instrum. Vol. 30, No. 11, 985-8 (Nov., 1959).

The sensing element of this monitor is a toroidal coil through which the beam passes undisturbed. With appropriate electronic circuity this permits the true shape of the current pulse to be viewed and also provides an indication of the average beam current on a meter in the range from 3×10^{-8} to 3×10^{-5} A. Furthermore, the use of the current monitor greatly simplifies the process of initially obtaining yield from the machine.

537.54 : 533.5

2407 PUMPING OF LINEAR ACCELERATORS. R.Jean and R.Liot.
Vide, Vol. 14, 311-19 (Sept.-Oct., 1959). In French and English.

The main features of the pumping system of the 1 BeV Orsay linear electron accelerator are described. The accelerator guide is 100 m in length, and is surrounded by a 16 cm diameter vacuum envelope. Each r.f. cavity is connected to this envelope by four 4 mm diameter holes. Two 500 litre/sec Apiezon C oil diffusion pumps, fitted with water and freon cooled baffles, are used on each 6 m section. In addition the r.f. input waveguides are provided with separate pumps. A vacuum of the order of 10^{-6} mm has been obtained, and maintained without difficulty. E.A.Ash

537.54

2408 THE EFFECT OF A SPACE CHARGE ON THE MOTION OF PARTICLES IN ACCELERATORS. V.I.Kotov and V.A.Pushtarik.
Atomnaya Energiya, Vol. 7, No. 3, 268-72 (Sept., 1959). In Russian.

A calculation is made of the screening effect of the chamber walls (assumed perfectly conducting) and of the electromagnet iron (assumed of infinite permeability). It is shown that this effect gives a correction of 10 to 20% in the non-relativistic case, but is of considerable importance at relativistic energies. J.B.Sykes

537.54

2409 MAXIMUM ALLOWABLE RADIAL FALL-OFF OF THE MAGNETIC FIELD IN A CYCLOTRON. A.Valeriu.
Rev. de Physique (Bucarest), Vol. 4, No. 2, 183-98 (1959). In Russian.

In order to focus particles in a cyclotron it is necessary for the magnetic field to fall off in a radial direction. At the centre it must thus exceed the resonance field, so that for the first few turns there will be a positive phase difference between the circulating ions and the accelerating electric field, but later this will become negative. Phase differences exceeding $\pi/2$ cannot be tolerated, and this limits the permissible radial fall-off of the magnetic field. Three methods of calculating the phase differences are described and used to show their dependence on the electric and magnetic fields and the geometry of the cyclotron. A.E.I. Research Laboratory

537.54

2410 THE INFLUENCE OF FRINGING ON BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A SECTIONED MAGNET. I. J.Teichman.
Czech. J. Phys., Vol. 9, No. 1, 47-66 (1959). In Russian.

A study is made of betatron oscillations in stray fields at the edges of magnets of an accelerator having a small radius. Two approximations for the motion of the stray fields (based on measurements) are used in the derivation of the nonlinear equations of motion of the particles. Transformation matrices of the boundary regions are derived. The case when an equilibrium trajectory encloses a general angle with the edge of the magnet is also treated.

537.54

2411 THE INFLUENCE OF FRINGING ON BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A SECTIONED MAGNET. II. J.Teichman.
Czech. J. Phys., Vol. 9, No. 3, 388-94 (1959). In Russian.

The influence of stray fields at the edges of the pole pieces on the deformation of the equilibrium trajectory and on the betatron oscillations is studied. A new definition of the effective length of segments for the approximate solution is given.

537.54

2412 THE PROTON SYNCHROTRON "SATURNE".
Onde elect., Vol. 39, 425-634 (June, 1959). In French.

A detailed, specialist, account of the design, construction and use of Saturne. After a preface by the High Commissioner of the French Atomic Energy Commission there are 35 papers with the following titles:

INTRODUCTION. R.Levy-Mandel, R.Maillet and S.D.Winter, (428-444).

MAGNET. Magnet principles and design. G.Bronca, H.Bruck, G.Gendreau, J.Hamelin, G.Neyret, J.Parain and M.Salvat, (445-449). Magnet construction and assembly. G.Armand and J.Lutz, (450-462). Magnetic properties of the magnet: Design and testing. G.Bronca, H.Bruck, J.Hamelin, G.Neyret and J.Parain,(463-472). Magnetic measuring equipment. A.Chonez, A.Gabet, E.Labois, P.Lerond, G.Rastoix and J.Taillet, (473-478). Magnet power supply. R.Beina P.Debraine, P.Ricateau and R.Klein, (479-486).

INJECTOR—INJECTION OPTICS—VACUUM CHAMBER. Injector. R.Vienet, (487-492). Principles of injection. G.Bronca, H.Bruck, G.Gendreau and M.Salvat, (492-505). Injection—Optics system. H.Bruck, G.Gendreau and M.Salvat, (505-511). Vacuum chamber. G.Armand, R.Le Quinio and F.Prevot, (512-522).

ACCELERATING SYSTEM. R.F.accelerating system: Basic design. J.Taillet, (523-525). Magnetic triggering of the integrator. M.Dagal, J.Lecomte and G.Rastoix, (526-529). Analogue computer controlling the master-oscillator. A.Gabet and J.Martin, (530-536). Master-oscillator. B.Chiron and R.Schoen, (537-542). Accelerating cavity. J.Lecomte, R.J.Le Gardeur and J.Taillet, (543-555). Ferrites and the magnetic circuit of the accelerating cavity. G.Delyon, G.Gomez, Y.Lescroel and A.Pierrot, (556-560). High-frequency amplifier used in the accelerating system. V.Glaude, B.Levy and G.Leproux, (560-563). Direct current transistor amplifier for 400 amp. V.Goursky and P.Gutmann, (564-567).

MONITORING AND CONTROLS. Monitoring and control system. P.Debraine, R.Segalas and R.Locque, (568-574). Timing system. R.Charbonnier, P.Debraine, G.Rastoix and R.Segalas, (575-581). Beam detection. J.C.Marchais, M.Y.Romain and G.Rommel, (582-587).

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MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

538

2413 MAGNETIC SUSCEPTIBILITY BALANCE USING A NULL TECHNIQUE. J.R.Singer.

Rev. sci. Instrum., Vol. 30, No. 12, 1123-4 (Dec., 1959).

A very sensitive magnetic susceptibility balance is described with the characteristic of providing a null reading over all field strengths whenever the sample is purely paramagnetic. The balance is used mainly for single crystal measurements of susceptibility at high and low temperatures. Any ferromagnetic impurity shows as a null deviation as the magnetic field strength is altered. The degree of unbalance obtained is readily used to substract out the ferromagnetic impurity from the paramagnetic and antiferromagnetic components of the susceptibility.

538 : 621.317.41

2414 ABSOLUTE METHOD OF MEASURING MAGNETIC SUSCEPTIBILITY. A.Thorpe and F.E.Senftle.

Rev. sci. Instrum., Vol. 30, No. 11, 1006-8 (Nov., 1959).

An absolute method of standardization and measurement of the magnetic susceptibility of small samples is presented which can be applied to most techniques based on the Faraday method. The fact that the susceptibility is a function of the area under the curve of sample displacement v. distance of the magnet from the sample, offers a simple method of measuring the susceptibility without recourse to a standard sample. Typical results on a few substances are compared with reported values, and an error of less than 2% can be achieved.

538 : 621.317.44

2415 SHAPE ANISOTROPY IN A WIDE-RANGE GAUSSMETER. F.E.Luborsky and L.I.Mendelsohn.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 248S-249S (April, 1959).

A direct-reading, wide-range, stable gaussmeter is described. It consists of a thin ferromagnetic film mounted on a shaft. This film reacts with a magnetic field to produce a torque whose magnitude is a function of the applied field intensity. The magnetic torque developed is indicated by the angular rotation of the shaft restrained by a spiral spring. Because the magnetic torque is derived from shape anisotropy of the film, the instrument has three most valuable characteristics. First, it cannot be decalibrated by any magnetic field; second, it can cover any useful range from 200 to 20 000 G; finally the gaussmeter can be used for alternating as well as static fields. An analysis of the torque-angle characteristics of this instrument has been made assuming that the magnitude of the film magnetization is uniform and constant and that its direction varies with the field direction and magnitude. Stoner and Wohlfarth's analysis for the ellipsoid which precludes domain boundary formation is used to calculate the anisotropy torque as a function of the applied field. The discrepancies between theory and experiment can be accounted for. Thus, the analysis should prove of interest to those engaged in research on thin films, while the gaussmeter itself has proved a valuable tool for those working with magnetic fields.

538

2416 FLUX INSTRUMENT FOR RAPID COMPARISON OF CRYSTAL ANISOTROPIES.

R.W.Cole and C.R.Honeycutt.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 250S-251S (April, 1959).

A rotating disk instrument for rapid comparison of crystal anisotropies is described. In it a circular disk rotates in a magnetic field parallel to the plane of the disk. Because of crystal anisotropy the magnetization I makes an angle θ with the magnetic intensity H. Some instruments, called torque magnetometers or magnetic torquemeters, measure the torque per unit volume, HI sin θ. In this instrument the disk rotates at 1800 rev/min with its axis perpendicular to H. The changes in I sin θ, the component of the magnetization perpendicular to H, induce an e.m.f. in pickup coils, which are placed with their common axis perpendicular to the axis of the rotating disk and perpendicular to H. If the pickup coils are spherical, as in the similar instrument built by Siegel, the ratio of the flux through the coil to the magnetic moment of the specimen can be accurately calculated. Without such an absolute calibration the flux instrument is nevertheless convenient for rapidly comparing the disks of oriented polycrystalline silicon-iron with a single crystal disk of the same dimensions. The standard deviation between percent orientations (relative torque peaks) determined with this flux magnetometer and a conventional torque magnetometer is 3%. The e.m.f. from the pickup coils is integrated electronically and displayed on an oscilloscope.

538 : 621.317.44

2417 DESIGN OF AUTOMATIC RECORDING INSTRUMENTS FOR MAGNETIC MEASUREMENTS IN A HOT CELL. W.S.Byrnes, R.G.Crawford and R.C.Hall.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 244S-245S (April, 1959).

Two remotely controlled, automatic recording instruments have been designed and constructed for making magnetic measurements in a hot cell: a torque magnetometer for crystal anisotropy measurements and a magnetostrictometer for magnetostriction measurements. The magnetometer automatically plots the torque exerted on a slowly rotating sample as a function of angular displacement with respect to the direction of the applied field. Its sensitivity is 2×10^3 erg/mV. The magnetostrictometer automatically plots strain as a function of applied field. Its maximum sensitivity is 0.2×10^{-3} in./in. mV. Emphasis is placed on design features that enable these instruments to be operated by remote control. In this type of hot cell work, the handling of the samples to be tested requires the use of an expert operator at the manipulator. For this reason tools and jigs are described that compensate for operator inexperience. Such tools are an automatic screw driver, a vacuum pickup, jigs for bonding prewound strain gauges to the samples, etc.

538 : 681.142 : 621.318.12

2418 RECENT ADVANCES IN MAGNETIC DEVICES FOR COMPUTERS. D.H.Looney.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 38S-42S (April, 1959).

Major advances in computer technology have been made by the use of magnetic devices. The speed of operation, storage capacity, and reliability of computers have been significantly increased by the development of the memory core. The present paper describes some of the newer magnetic elements which may replace ferrite toroids in memory matrices. Ferrite materials are being used as sheets, which show great promise in achieving a cost reduction, and as multiaperture devices which in memory applications offer the advantages of increased speeds, a wider operating temperature range, and nondestructive readout. The ferromagnetic materials are used in the form of thin films which are capable of increased switching speeds at nominal current drives. The use of magnetic wire as a storage element offers new fabrication technology, a wider operating temperature range, and new functional structures. A comparison is made to highlight the device characteristics of the various structures.

538

2419 APPARATUS FOR THE MEASUREMENT OF TENSOR PERMEABILITY AND DIELECTRIC PROPERTIES OF FERRITES AT X-BAND FREQUENCIES. W.S.Carter.

Marconi Rev., Vol. 22, 154-63 (3rd Qtr, 1959).

An apparatus for measuring tensor permeability and dielectric constant has been constructed in two consecutive forms, both of which are described. Determination of quantities requires measurements of Q-value change and resonant frequency shift of the microwave cavity containing the specimen. In the second and more satisfactory apparatus these measurements are made by an a.c. method. Dielectric measurements are made in an E_{010} cavity and magnetic measurements in an H_{113} cavity. For dielectric measurements, using a cavity of volume 12.3 cm^3 and a specimen volume 0.1 cm^3, the limiting value of tan δ_ϵ which can be measured is 3.5×10^{-5}. For magnetic measurements the limiting value of tan δ_μ is 5×10^{-2} for the same volumes. S.A.Ahern

538 : 681.142 : 621.318.1

2420 REVERSIBLE, DIODELESS. TWISTOR SHIFT REGISTER. A.H.Bobeck and R.F.Fischer.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 43S-44S (April, 1959).

A twistor shift register has been built and operated successfully. The design utilizes interaction effects which exist between magnetized regions on a magnetic wire. Only a single magnetic wire is required for a complete register. The information is stored as magnetically polarized zones which can be moved along the wire by means of a five phase pulse source. No diodes are required. Therefore, drive powers can be greatly decreased since the only threshold consideration is the magnetic material itself. Bi-directional operation is easily secured. The upper frequency limit has not been established; however, a several hundred kilocycle bit rate should be possible. Physically, the register could be made of no more than magnetic and copper wire. This should make fabrication considerably cheaper than conventional shift registers.

538 : 621.318.12 : 621.374.32

2421 MILLIMICROSECOND SWITCHING PROPERTIES OF FERRITE COMPUTER ELEMENTS. W.L.Shevel, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 47S-48S (April, 1959).

An examination of the switching properties of square loop ferrites is presented. Switching times have been studied over the range 5 μsec to 10 mμsec. The switching parameters, threshold field and switching constant, have been studied as a function of temperature and of ceramic processing. The plot of inverse of switching time against applied fields displays three nearly linear portions for which the slopes vary by a factor of from two to ten. The inverse slope known as the switching constant of the material has therefore three values; this is interpreted as indicating three mechanisms to be responsible for the process of flux reversal, each mechanism being dominant over a certain region of the switching curve. These mechanisms are proposed as being wall motion, incoherent rotation, and coherent rotation. A model allowing a coherent rotation process is proposed. Data are presented for several ferrites which have widely varying properties.

538 : 621.318.12 : 621.374.32

2422 STUDY OF THE RESIDUAL STATES OF FERRITE CORES IN COMPUTER MEMORY OPERATION. W.M.Overn and V.J.Korkowski.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 52S-53S (April, 1959).

The two complimentary residual states of magnetic induction used to represent binary information in a ferrite core storage system have been studied. The flux density found at the two states depends on any large fields which may have saturated the core in the past, as well as on the nature of the driving fields employed in the system. The partial-select noise amplitude is a function of the residual magnetic induction and saturation history. By applying this information, "Delta" noise can be eliminated. The role of the post-write disturb pulse in preventing errors under certain abnormal operating conditions has been determined.

538 : 621.318.12 : 621.374.32

2423 INHIBITED FLUX — A NEW MODE OF OPERATION OF THE THREE-HOLE MEMORY CORE. J.A.Baldwin, Jr and J.L.Rogers.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 58S-59S (April, 1959).

A new method of operation of the three-hole memory core has been developed. As is the case with the coincident-flux scheme developed by I.B.M., read and write times may be made very short. However, by using single-line drive rather than coincident current, one need pass but one conductor through each hole. A description is given of a small memory array which uses this method.

538 : 621.395.625.3

2424 MAGNETIC RECORDING HEAD WITH D.C. RESPONSE. R.E.Fischell and S.J.Meehan.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 246S-247S (April, 1959).

A magnetic recording head has been developed to directly record and play back low-frequency signals, down to and including zero c/s, without using amplitude, frequency, or pulse width modulation. Two problems are encountered in d.c. magnetic recording. The more obvious problem is caused by the small voltage induced in the playback head when the flux changes at a very slow rate. At low frequencies, the output of a conventional playback head is proportional to the time rate of change of flux in the head; therefore, at d.c. the playback signal has zero amplitude. The second problem encountered in reproducing d.c. signals is the disappearance of the magnetic field at the gap of a ring-type head when wavelengths of considerable lengths are recorded on the tape. The magnetic field at the gap of a ring-type head becomes too small to be used when a recorded wavelength is longer than a few inches. Combining a perpendicular head with flux sensitive playback has eliminated these two problems. A perpendicular head magnetizes the recording tape perpendicularly to the direction of tape motion, i.e., the tape is magnetized through its thickness. The pole pieces of the head are spring loaded and pressed against the tape to maintain consistent contact while the tape passes through the head. Vicalloy, in the form of a thin, homogeneous metal tape, was selected for this purpose because it contains many of the magnetic and physical characteristics desired, including a high coercive force, high remanence, and mechanical flexibility when it is rolled into a thin tape. A frequency response of d.c. (0 to 10 c/s) is achieved at a tape speed of 0.027 in./sec. Pre-emphasis is not required in recording and equalization is not used during playback. Cross talk between adjacent heads in a multichannel system is below 50 dB at moderate track separations.

538.1 : 621.318.381

2425 ELECTROMAGNETIC SUPPORT ARRANGEMENT WITH THREE-DIMENSIONAL CONTROL. I. THEORETICAL. A.W.Jenkins and H.M.Parker.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 238S-239S (April, 1959).

The original electromagnetic support developed in the late 1930's is a one-dimensional system. Servoed control is obtained in one direction and only inherent stability due to the field shape is obtained in the lateral directions. In this paper the more general problem of a three-dimensionally controlled support is treated theoretically. By virtue of making certain assumptions which seem reasonably close to practical feasibility two basic three-dimensional support schemes have been devised, in which ideally the three mutually perpendicular forces are uncoupled. The two arrangements are described and the theory is applied to predict support performance and to predict the amount of coupling to be expected due to deviations from the ideal system.

538.1 : 621.318.381

2426 ELECTROMAGNETIC SUPPORT ARRANGEMENT WITH THREE-DIMENSIONAL CONTROL. II. EXPERIMENTAL. H.S.Fosque and G.Miller.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 240S-241S (April, 1959).

The first gradient coil configuration described in Part I (see preceding abstract) has been constructed. In this system the axis of one pair of gradient coils is parallel to the magnetizing field. Details of the mechanical, magnetic, optical, and electronic aspects of this implementation are presented and discussed.

538.1 : 621.318.2 : 621.316.719

2427 STRONG EDDY-CURRENT APPLICATIONS OF PERMANENT MAGNETS. K.Tendeloo.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 236S-237S (April, 1959).

Small eddy-current brakes for kWh meters have a practically linear torque—speed characteristic, because the induced current increases proportionally to the low relative speed between eddy-current disk and magnetic poles. In bigger designs a considerable reaction of the induced-current field shifts the eddy-current paths in the direction of movement, so that the electrodynamic force between current and magnetic poles deviates from the linear relation, reaches a maximum at a critical speed, and decreases asymptotically to zero at infinite speed, whereas the dissipated power becomes a maximum. Some investigations were made into the behaviour of permanent magnets with a water-cooled setup with p.m.

rotor and an air-cooled device with p.m. stator, both of cylindrical shape with 11.8 in. effective diameter and an axial length of 5.5 in. and 6 in., respectively. Maximum torques of 410 ft lb and 304 ft lb were obtained. Pole pieces may sometimes increase the static flux, but do not always improve the dynamic behaviour. The ideal solution might be obtained with a high-induction magnet without pole pieces, but the induction in available materials is limited by the demagnetizing effect on the free pole top. Possible applications could be found in a retarder for heavy trucks in mountainous districts and in a flexible coupling, slipping with decreasing torque when overloaded.

538.2

2428 OBSERVATIONS OF THE MAGNETIC AFTER-EFFECTS IN FERROMAGNETICS. E.I.Trinkler.

Latv. PSR Zinat. Akad Vestis, No. 6(143), 83-6 (1959). In Russian.

The "after-effect" is the time-lag of magnetization state behind sudden change in field. The method used is based on that of Telesin and Lednev (See Abstr. 5457 of 1957). Cylindrical specimens of "electrode" steel were placed in turn in a solenoid. Field switching was achieved by a thyratron circuit. A detector coil was wound on the specimen and the signals produced on this were passed to an amplifier of established linearity and thence to an oscillograph. The results are expressed as graphs of rate of fall of intensity of magnetization against time. They indicate that time of fall decreases with decreasing specimen length. The results to date are qualitative only. N.Davy

538.27

2429 NUCLEAR MAGNETIC RESONANCE IN MAGNETIC MATERIALS. R.G.Shulman.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 224S (April, 1959).

The following note only is given:-

In a nuclear magnetic resonance experiment the relation between the resonance frequency and the magnetic field is $\omega = \gamma_N \times H$, where γ_N is the nuclear gyromagnetic ratio. In general the resonance frequency for a nucleus in a magnetic substance is different from the resonance frequency in a diamagnetic environment because the internal magnetic fields contribute a time average component to H at the nuclear site. By measuring the resonance shifts one can obtain information about the distribution of magnetic electrons in the material and the magnetization, including the elusive sublattice magnetization in antiferromagnetic crystals. Measurements of resonance shape and relaxation time contribute to the understanding of the time dependence of the electronic states.

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

538.3

2430 ON THE GEOMETIZATION OF ELECTROMAGNETISM. A.Das.

Nuovo Cimento, Vol.13, No.2, 451-2 (July 16, 1959).

The configuration space-time associated with a charged test-particle and its equation of motion are represented by a four-dimensional Riemannian manifold together with its geodesic equation. In the linearized approximation to the metric the field equation, in the quasi-static approximation, is shown to yield four electromagnetic equations. For the case of an electron in the field of a nucleus the field equation can be solved exactly to give the metric but the implied slight departure from the Coulomb potential leads to a level shift in hydrogen which does not agree with the Lamb–Retherford value. T.R.Carson

538.3

2431 SEVERAL POSSIBILITIES ASSOCIATED WITH THE SEPARATION OF CHARGED PARTICLES IN AN INHOMOGENEOUS HIGH-FREQUENCY ELECTROMAGNETIC FIELD. M.A.Miller.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 809-10 (Sept., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 3, 561-2 (March, 1959).

Extends previous work (Abstr. 5956, 8146 of 1958) taking into account the reaction of the motion of the particles on the potential. In particular the effect of particles leaving the field is examined and several possible applications are suggested. J.W.Sturgèss

538.3 : 530.12

UNIFORM ELECTROMAGNETIC FIELD IN THE THEORY OF GENERAL RELATIVITY. See Abstr. 2111

538.3

2432 "PROGRESSING-WAVE" [AVTOMODEL' NYE] MOTIONS AND A POINT EXPLOSION IN THE MAGNETOHYDRODYNAMICS OF AN INFINITELY CONDUCTING GAS. D.V.Sharikadze.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 6, 1183-6 (Aug. 21, 1959). In Russian.

The author considers the plane or cylindrically symmetric unsteady flow of a non-viscous perfectly conducting ideal gas for situations where the logarithm of the magnetic field is proportional to the entropy. By assuming a special type of solution involving functions of one variable only, the equations of motion are reduced to ordinary differential equations. Further specialization yields solutions of these equations describing two plane parallel shock waves or a cylindrical shock wave expanding into a stationary gas which already contains a suitable current distribution. O.Penrose

538.3

2433 THE SPLITTING OF A SMALL DISCONTINUITY IN MAGNETOHYDRODYNAMICS. G.Ya.Lyubarskii and R.V.Polovin.

Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1291-3 (Nov., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 901-2 (May, 1959).

The initial discontinuity breaks up into seven waves, three propagated in each direction and one, a contact discontinuity, remaining stationary. Relations between the discontinuities in hydromagnetic quantities are quoted for the various wave types. R.A.Newing

538.3 : 532.7

EXPERIMENTS ON THE INSTABILITY OF A LAYER OF MERCURY HEATED FROM BELOW AND SUBJECT TO THE SIMULTANEOUS ACTION OF A MAGNETIC FIELD AND ROTATION. See Abstr. 2169

538.3 : 537.56

HYDRODYNAMIC ANALYSIS OF THE COMPRESSION OF A RAREFIED PLASMA. See Abstr. 2367

538.3 : 534.22

HYDROMAGNETIC SHOCK WAVES. See Abstr. 2203

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.56 : 621.375.9

2434 CAVITY MASER EXPERIMENTS USING RUBY AT S-BAND. W.S.C.Chang, J.Cromach and A.E.Siegman.

J. Electronics and Control, Vol.6, No.6, 508-26 (June, 1959).

A three-level solid-state maser using ruby has been operated at frequencies near 3 kMc/s, using a high-efficiency cavity having T.E.M. modes in a rectangular geometry. Two different operating points in the $\theta = 10^0$ to $\theta = 30^0$ region of the ruby spectrum gave maser operation with a pump frequency near 10.5 kMc/s, although the inversion obtained was a sensitive function of the exact operating point. An operating point at $\theta = 90^0$, requiring pumping at 13.5 kMc/s, gave a gain–bandwidth product of better than 50 Mc/s. It was also found possible to pump the 1–4 or $\Delta M = 3$ transition at this same operating point, obtaining 3 kMc/s amplification with a 23.7 kMc/s pump frequency. Although this mode of operation was not fully explored, it is potentially capable of increasing the gain–bandwidth product by a substantial amount.

538.56

2435 SPONTANEOUS RADIATION OF A PARAMAGNETIC IN A MAGNETIC FIELD. V.M.Fain.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1032-3 (April, 1958). In Russian. English translation in : Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 714-15 (Oct., 1958).

If a system of n particles, each of which has two available energy states (they may be molecules, in a gas, nuclei or electrons in a solid etc.), starts with all the particles in the higher state then the system will make radiative transitions to the lower state in a time $2\tau_{r,\varrho}$ where $\tau_{r,\varrho} = \ln n/n\gamma_0$ and where γ_0 is the natural line width of one particle. A continuously radiating system may be realized at low temperatures in a periodically reversing magnetic field. If the electrons in the paramagnetic are in their lower levels and the field is reversed each particle gains an energy $g\beta H$ and the angular frequency of the radiation ω is given by $g\beta H/\hbar$. Subject to the field reversal time τ_h obeying certain conditions the power radiated is given by $n\hbar\omega/(\tau_h + 2\tau_{r,\varrho})$. In a practical case it is estimated that a sample of $n = 10^{17}$ particles (which may be electrons in a volume of 0.35 cm^3) with $\omega = 6.3 \times 10^{10}$ sec^{-1}, i.e. $\lambda = 3$ cm, yields a mean power of 0.7×10^{-9} W. The line width is of the order 10^{-8} sec^{-1}. R.Parker

538.56

2436 STIMULATED R.F. AMPLIFIER WORKING ON HYPERFINE LEVELS OF PARAMAGNETIC ATOMS.

K.A.Valiev and Sh.Sh.Bachkirov.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(2), 302-3 (July, 1958). In Russian. English translation: Soviet Physics—JETP (New York), Vol. 35(8), No. 1, 208-9 (Jan., 1959).

The possibility of obtaining r.f. amplification in the frequency range 10^8–10^9 c/s by employing transitions between hyperfine levels in paramagnetic ions is considered. The copper isotope, Cu^{65}, in divalent compounds has suitable relaxation parameters at liquid helium temperatures. It is shown that, in general, for the iron group (Fe, Co, Ni) the frequency at which amplification will be possible will be about 10^8 c/s, and for the rare-earth group about 10^9 c/s. S.A.Ahern

538.56 : 539.2 : 537.311

2437 USE OF CYCLOTRON RESONANCE IN SEMICONDUCTORS FOR THE AMPLIFICATION AND GENERATION OF MICROWAVES. A.S.Tager and A.D.Gladun.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 808-9 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 560-1 (March, 1959).

If the motion of the carriers is anharmonic the usual selection rules break down and transitions appear for $\Delta n = \pm 2$, 3 etc. This leads to the possibility of a maser-type oscillator or amplifier. Calculations of important parameters are given and it is claimed that shorter wavelengths can be generated with cyclotron resonance than with paramagnetic resonance. A system is also described for using cyclotron resonance when anharmonic motion is not pronounced. D.J.Oliver

538.56

2438 COMPACT PASSIVE NONRECIPROCAL STRUCTURES FOR UHF FREQUENCIES. H.Seidel.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 156S (April, 1959).

The following note only is given: Techniques employed in forming passive nonreciprocal circuitry at microwave frequencies prove awkward at the lower frequencies. A new means is discussed employing lumped parameter circuitry for providing compact constructions in this lower range of frequencies. Experimental resonance isolator structures have provided successful results at both 500 Mc/s and 130 Mc/s for which isolation ratios of better than 10:1 have been achieved over significant bandwidths.

538.56

2439 WAVE-FRONT VELOCITY IN ELECTRODYNAMICS CONTAINING HIGHER DERIVATIVES. L.G.Yakovlev.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 782-3 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 542-3 (March, 1959).

The field is defined in terms of fourth-order differential equations and the wave-front is taken to be a surface of weak discontinuity. A quartic equation is derived for the possible velocities of propagation. R.A.Newing

538.56

2440 A NOTE ON DIFFRACTION BY AN INFINITE SLIT. R.F.Millar.
Canad. J. Phys., Vol. 38, No. 1, 38-47 (Jan., 1960).

The two-dimensional problem of diffraction of a plane wave by a narrow slit is considered. The assumed boundary values on the screen are the vanishing of either the total wave-function or its normal derivative. In the former case, a differential-integral equation is obtained for the unknown function in the slit; in the latter, a pure integral equation is found. Solutions to these equations are given in the form of series in powers of ϵ (where ϵ/π is the ratio of slit width to wavelength), the coefficients of which depend on $\log \epsilon$. Expressions are found for the transmission coefficients as functions of ϵ and the angle of incidence; these are compared with previous determinations of other authors. A brief outline is given for the treatment of diffraction of a cylindrical wave by the slit.

538.56

2441 DIFFRACTION BY A UNIDIRECTIONALLY CONDUCTING HALF-PLANE. R.A.Hurd.
Canad. J. Phys., Vol. 38, No. 2, 168-75 (Feb., 1960).

The problem of the diffraction of a plane electromagnetic wave by a unidirectionally conducting half-plane is solved by transform techniques. A comparison is made with the results previously obtained by Karp (1957).

538.56 : 534.26

2442 DIFFRACTION BY A SPHEROID. B.R.Levy and J.B.Keller.
Canad. J. Phys., Vol. 38, No. 1, 128-44 (Jan., 1960).

The diffraction of a spherical scalar wave by a hard or soft spheroid is investigated theoretically. First the diffracted field is determined by the geometrical theory of diffraction. Then for comparison the corresponding boundary value problem is solved exactly in terms of a series of products of spheroidal functions. The series involves the "radial" eigenfunctions which correspond to appropriate complex eigenvalues. Asymptotic expansions are derived for these functions for large values of the variable and the parameter. When used in the series solution, these expansions yield the asymptotic form of the diffracted field for incident wavelengths small compared to the spheroid dimensions. This result coincides precisely with that given by the geometrical theory. This agreement provides another verification of that theory. The expressions for the field is used to calculate the backscattering and the field on the spheroid. The electromagnetic backscattering is finally computed with the aid of a theorem which relates it to the two scalar results.

538.56 : 534.26

TRANSIENT DIFFRACTION OF SCALAR WAVES BY A FIXED SPHERE. See Abstr. 2208

538.56 : 621.396.677

2443 ANALYSIS AND SYNTHESIS OF RADIATION PATTERNS FROM CIRCULAR APERTURES.

A.Ishimaru and G.Held.
Canad. J. Phys., Vol. 38, No. 1, 78-99 (Jan., 1960).

Considers the problem of determining the source distributions over a circular aperture required to produce a prescribed radiation pattern. In particular, the problem of optimizing the narrow broadside pattern from a circular aperture is discussed in detail and an improved design method over Taylor's [Abstr. 3927 B of 1955, Trans Inst. Radio Engrs Prog. Group on Antennas and Propagation, AP-3, No. 1, 16-28 (Jan., 1955)] for line source is devised. Numerical examples are given. The analysis of the radiation pattern from a circular aperture from r_1 to r_2 with the travelling-wave type source functions is then given. Expressions suitable to the analysis and the synthesis are obtained and the narrow-beam and shaped-beam synthesis are discussed.

538.56 : 537.56

2444 NONLINEAR INTERACTION OF RADIO-WAVES PROPAGATING IN A PLASMA. V.L.Ginzburg.
Zh. eksper. teor. Fiz., Vol. 35, No. 6(12), 1573-5 (Dec., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35, No. 6, 1100-1 (June, 1959).

It is pointed out that in a non-uniform isotropic plasma as well as in a uniform magneto-plasma the tensor permittivity depends non-linearly on the electric field. If a number of waves propagate in such media linear intermodulation components are found to arise. G.D.Sims

538.56 : 537.56

DAMPING OF ELECTROMAGNETIC WAVES IN A PLASMA. See Abstr. 2366

538.56 : 621.372.831.4

2445 HIGH-PRESSURE MICROWAVE WINDOW. A.W.Lawson and G.E.Smith.

Rev. sci. Instrum., Vol. 30, No. 11, 989-91 (Nov., 1959).

Two conically tapered single crystals of Al_2O_3, with small ends abutting, are used to simultaneously effect a high pressure seal and provide a matched transformation from a standard 1 cm circular waveguide at atmospheric pressure to a circular waveguide terminated by a high-Q cavity resonator with an internal hydrostatic pressure up to 10^4 bars.

538.56

2446 EVANESCENT MODES IN A PARTIALLY FILLED GYROMAGNETIC RECTANGULAR WAVEGUIDE. Chen To Tai.

J. appl. Phys., Vol. 31, No. 1, 220-1 (Jan., 1960).

The general problem of an inhomogeneous gyromagnetic rectangular waveguide has been studied, using a scalar formulation. This yields a modified Sturm-Liouville differential equation, which has been used to investigate the basic behaviour of the transverse electric modes existing in the guide. S.A.Ahern

538.56 : 621.372.852.2

2447 THE REGGIA–SPENCER MICROWAVE PHASE SHIFTER J.A.Weiss.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 153S-154S (April, 1959).

The essential properties of the waveguide phase shifter reported by Reggia and Spencer are explained by means of a composite phenomenological model which incorporates the two dominating effects: the elliptic waveguide symmetry and a dielectric waveguide effect. The model provides an advantageous starting point for more precise calculations, as well as a qualitative guide to further device development. It also sheds further light on Faraday rotation and its associated interference effect under conditions of elliptic symmetry.

538.56 : 539.2 : 538.2 : 621.375.9

2448 MICROWAVE AND LOW-FREQUENCY OSCILLATIONS DUE TO RESONANCE INSTABILITIES IN FERRITES. M.T.Weiss.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 146S-147S (April, 1959).

Microwave and low frequency oscillations have been observed in single crystal yttrium iron garnet disks placed in a microwave cavity with an applied d.c. field normal to the disk. These oscillations occur when the microwave power incident on the cavity exceeds a certain critical value in the milliwatt range. The oscillations occur as sidebands above and below the incident frequency and can also be observed as a modulation of the microwave output of the cavity. The above phenomenon is associated with the ferromagnetic resonance instability due to the fact that the resonant frequency of a disk depends on M_z and thus on the r.f. magnetic field used to drive it. The combination of the disk and the resonant cavity with high power, provides the conditions necessary for relaxation oscillations to be set up.

538.56 : 621.372.852.22

2449 LIMITATIONS OF ELEMENTARY MODE CONSIDERATIONS IN FERRITE LOADED WAVE GUIDE. R.C.Fletcher and H.Seidel.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 147S-148S (April, 1959).

A consideration of the fundamental TE modes in a wave guide containing a low-loss ferrite slab leads to a mode with a group velocity corresponding to power transfer in a single direction only. A completely reactive isolator, however, is prohibited by general energy conservation principles. Analysis of a rectangular wave guide with a ferrite slab against one wall, showed that there are higher order propagating modes wherever the unidirectional TE mode is cut off. Furthermore, it can be experimentally demonstrated that these modes can be excited from a simple boundary with no variations along the magnetic field. It is suggested that these modes may carry the power when the unidirectional TE mode is cut off. An experimental situation in which the proposed reactive isolator is tried is described. Where the reactive isolator should be cut off and perfectly reflecting, it is highly absorptive. This can be explained by the lossiness of the higher order gyromagnetic modes.

538.56 : 537.54

2450 FIELDS IN SLANTED-GAP EXCITED RECTANGULAR DUCTS. J.Van Bladel.

Nuclear Instrum. and Methods, Vol. 3, No. 2, 109-15 (Aug., 1958).

Some features of the electromagnetic field in a rectangular wave guide, cut in two by a plane making an angle θ with the guide's longitudinal axis, are examined. The field is excited by a voltage applied across the two halves of the guide. Several values of θ, frequency (between zero and cut-off), and aspect ratio of the cross-section are considered. The problem is of interest for the design of particle accelerators, and, with this particular application in mind, data are presented for the energy and momentum kicks which particles experience when crossing the gap.

538.56 : 621.396.96

2451 THE RADAR CROSS SECTION OF A SEMI-INFINITE BODY. H.Brysk.

Canad. J. Phys., Vol. 38, No. 1, 48-56 (Jan., 1960).

The concept of cross-section as applied to a semi-infinite scattering body seems to require some clarification. The need for careful formulation of the problem arises because of the simultaneous occurrence of two characteristic lengths tending to infinity: the range from the radar to the target, and the size of the target. The infinite range assumption in the definition of the cross-section allows the incident wave to be approximated as a plane wave in the case of a finite scatterer. For a semi-infinite body, it is customary to retain the plane-wave incidence, and introduce ad hoc arguments to dispose of the awkwardness due to the infinite extent of the scatterer. A return to the basic definition of a cross-section, and examination of its motivation, lead here to an unequivocal formulation for the cross-section of a semi-infinite body. Its consequences are pursued in the physical optics approximation. In particular, the nose-on backscattering from a body of revolution is exhibited, and results are computed for the paraboloid and the cone (which turn out to agree with the traditional ones). The broadside backscattering from a cylinder is also calculated, and the difference in this case between monostatic backscattering and the return in the backward direction from an incident plane wave is discussed.

538.56 : 621.396.677.32

2452 THE RADIATION CHARACTERISTICS OF A SINUATE ANTENNA. S.C.Loh.

Canad. J. Phys., Vol. 38, No. 1, 119-27 (Jan., 1960).

Rigorous expressions for the radiation field of an aerial of sinusoidal shape are derived on the assumption of a travelling-wave type of current distribution along the conductor. In order to illustrate the derived results an endfire aerial is designed and some calculations of radiation field are presented.

538.56 : 551.5

AN AERIAL TO ELIMINATE GROUND-WAVE INTERFERENCE IN IONOSPHERIC SOUNDING EXPERIMENTS. See Abstr. 2003

Radiofrequency Spectroscopy Techniques

538.56

2453 TEMPERATURE EFFECTS IN NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. G.Slomp.

Rev. sci. Instrum., Vol. 30, No. 11, 1024-7 (Nov., 1959).

The effect of temperature on the stability of the Varian V-4300-2 n.m.r. spectrometer has been investigated. The spectrometer was most sensitive to changes in room air temperature. A change of 0.3°C per minute caused a spectrometer drift of about 20 c/s. per minute. A change of 0.1°C per minute in temperature of magnet cooling water caused a spectrometer drift of 1 c/s per minute. Enclosing the magnet served to minimize effects of air temperature changes but amplified the effects of water temperature changes. Satisfactory control was attained by running the refrigeration units continuously and regulating the temperatures by controlling the suction pressure on the evaporators. Under these conditions spectra were reproducible to within $\frac{1}{2}$ c/s.

538.56 : 518.5 : 681.142

2454 ANALOG INTEGRATOR FOR E.P.R. SPECTRA. R.P.Schwenker.

Rev. sci. Instrum., Vol. 30, No. 11, 1012-13 (Nov., 1959).

An electromechanical analogue integrator for obtaining a continuous time integral of varying voltage is described. It is suited for applications where integrating times of greater than one minute are encountered. Particular consideration is given to its applicability to magnetic resonance data reduction.

NUCLEAR AND ATOMIC PHYSICS

APPARATUS . PARTICLE DETECTORS

539.1.07

2455 A GRAPHITE 4π GAMMA IONIZATION CHAMBER. J.J.Engelmann.

C.R. Acad.Sci.(Paris), Vol. 249, No. 17, 1628-30 (Oct. 28, 1959). In French.

The cylindrical electrodes of this chamber are arranged so that their separation is smaller at the centre than at the ends of the cylinder. This increases the volume of field uniformity, and thus also the sensitivity of the chamber and the size of the γ-source ampoule which can be placed within the field. A scale diagram is given. D.V.Mabbs

539.1.07

2456 DISTINGUISHING BETWEEN He^3 AND He^4 PARTICLES BY 'dE/dx' AND "E" MEASUREMENTS. R.W.P.McWhirter, P.Palit and E.H.Bellamy.

Nuclear Instrum. and Methods, Vol.3, No.2, 80-4 (Aug., 1958).

A new type of detector has been built to distinguish between He^3 and He^4 particles of a continuous energy spectrum ranging from about 10 to 30 MeV. It consists of two gridded ionization chambers which measure the total energy of the particle in two fragments "E_1" and "E_2", in general E_1 being $< E_2$. The information is displayed in a cathode ray oscilloscope by a series of spots whose coordinates are proportional to the values of E_1 and E_2 for each particle. The positions of the spots are compared to calculated positions to determine the total energy and mass of the particle concerned. The apparatus has been used to study the reaction $\gamma + He^4 \rightarrow \pi^0 + He^4$ by picking up the recoil α-particle amidst a large background of $He^3$and singly charged particles. It has been used to investigate the photodisintegration of oxygen, argon and krypton at high energies.

539.1.07

2457 COINCIDENCE COUNTING WITH SCINTILLATION COUNTERS. H.S.Murdoch and K.W.Ogilvie.

Nuovo Cimento, Vol. 14, No. 4, 661-72 (Nov. 16, 1959).

An examination is made of the factors affecting the coincidence technique when scintillation counters are used. Approximate expressions for the distribution of random time delays due to the photomultipliers are employed to derive the dependence of the so called "prompt" and "delayed" counting rates upon the inserted delay especially when this is small. Comparison with experiment shows that these expressions are applicable in many cases. The choice of optimum resolving time is treated, and the characteristics of coincidence circuits discussed.

539.1.07

2458 A NEW METHOD IN GAMMA-RAY SPECTROSCOPY : A TWO CRYSTAL SCINTILLATION SPECTROMETER WITH IMPROVED RESOLUTION. A.M.Hoogenboom.

Nuclear Instrum. and Methods, Vol.3, No.2, 57-68 (Aug., 1958).

A new method has been developed to measure the spectra of gamma radiation emitted in cascade disintegrations. Use is made of a two-crystal scintillation spectrometer and a gated multichannel analysing device. The pulses produced by summing the outputs of the two crystal-photomultiplier combinations are selected by a single-channel differential discriminator. The output of this differential discriminator gates the multi-channel analyser whenever the sum pulse corresponds to the release in the crystals of the full energy available in the cascade. The spectrum displayed is that of either of the two detectors. The most important features of the technique are : (a) only "full-energy" peaks are detected; (b) improved resolution is obtained especially at higher gamma-ray energies; (c) one γ-γ or p-γ-γ angular correlation experiment determines the angular correlation of the gamma rays of all double cascades de-exciting a given level. Details of operation and typical spectral are presented. It is suggested that the technique be called the "sum-coincidence" method.

539.1.07

2459 LARGE CRYSTAL TOTAL ABSORPTION SPECTROMETER. S.Standil and W.D.Loveridge.

Rev. sci. Instrum., Vol. 30, No. 10, 931-3 (Oct., 1959).

A total absorption scintillation spectrometer has been built primarily for the study of the neutral component of cosmic radiation. The high energies involved necessitate a large NaI(Tl) crystal (~ 70 lb) completely surrounded by an efficient anticoincident shield. The design and performance of this instrument are discussed.

539.1.07 : 621.374.32

2460 FAST COINCIDENCES WITH SLOW SCINTILLATORS. F.T.Arecchi.

Energia nucleare, Vol. 6, No. 11, 717-26 (Nov., 1959).

Two different methods for dealing with output pulses from a slow scintillation counter are described. These methods were introduced in order to achieve good time resolution in time measurements. Two devices were designed and their technical features are discussed. Experimental results are compared with theoretical calculations.

539.1.07 : 537.533

SCINTILLATION-DETECTOR OUTPUT-PULSE SPECTRUM. EFFECT OF PHOTOCATHODE SENSITIVITY. See Abstr. 2381

539.1.07 : 535.37 : 539.2

DIRECTIONAL DEPENDENCE OF THE SCINTILLATION RESPONSE OF ANTHRACENE TO α-IRRADIATION. See Abstr. 1754

539.1.07

2461 GAS ČERENKOV COUNTERS. J.H.Atkinson and V.Perez-Mendez.

Rev. sci. Instrum., Vol. 30, No. 10, 864-8 (Oct., 1959).

A gas Cherenkov counter is described which is suitable for charged-particle detection in the BeV region (β from 0.980 to 0.999). Calibrations of the counting efficiency are included along with a table of indices of refraction of suitable gases. The use of this counter as a threshold detector to discriminate between elastic and inelastic pions in the momentum range of 1 to 2 BeV/c is discussed. Use of the counter to differentiate between charged particles of different mass in a momentum-analysed beam is also considered.

539.1.07 : 621.383.27

2462 LUMINESCENT EFFECTS IN PHOTOMULTIPLIER TUBE FACES AND PLEXIGLAS CERENKOV DETECTORS. K.A.Anderson.

Rev. sci. Instrum.,Vol.30, No.10, 869-73 (Oct., 1959).

By means of 20 and 35 MeV proton beams obtained from the University of Minnesota Linac, luminescent effects in Plexiglas Cherenkov detectors have been investigated. It was found that 1% of the protons entering the detector produced light pulses which overlapped the μ-meson Cherenkov light distribution. These light pulses correspond to energy losses in a sodium iodide crystal of mainly less than 20 keV. Luminescent effects in the glass face of the particular photomultiplier employed were also studied and found to be quite large.

539.1.07

2463 THREE-DIMENSIONAL SCINTILLATION DOSIMETER. G.L.Olde and E.Brannen.

Rev. sci. Instrum., Vol. 30, No. 11, 1014-16 (Nov., 1959).

A dosimeter for electron beams has been constructed which utilizes the luminescence of plastic phosphors under electron bombardment. A phosphor, in sheet form, was placed in a Lucite medium and the luminescence of a small volume of the phosphor was focused on a photomultiplier. By scanning the phosphor, the three-dimensional dose distribution within the medium was determined. Special attention was paid to obtaining the dose close to the surface of the medium by which the electron beam entered.

539.1.07

2464 ON THE THEORY OF THE DIFFUSION CLOUD CHAMBER. I.Saavedra.

Nuclear Instrum. and Methods, Vol.3, No.2, 85-9 (Aug., 1958).

A revision is made of Shutt's (Abstr. 356 of 1952) theory by using more accurate expressions describing the transport phenomena in the chamber. This leads to a new expression for the temperature gradient. The importance of the correction thus introduced depends upon the particular components of the binary mixture considered.

539.1.07

2465 TRACK DISTORTION IN A LIQUID HYDROGEN BUBBLE CHAMBER. R.Budde, A.Burger, F.Filthuth, Y.Goldschmidt-Clermont, H.M.Mayer, D.R.O.Morrison, C.Peyrou

and J.Trembley.
Nuovo Cimento, Vol. 14, No. 4, 778-86 (Nov. 16, 1959).

Tracks of 270 MeV pions in a 10 cm hydrogen bubble chamber were measured with the CERN reprojection system (Iep). As a test of track distortion, the curvature of the parabola fitted to the points and the dispersion of these points were calculated. With flash delays of 1 and 2 m sec the curvature in the middle region of the chamber was almost the same as that expected from multiple scattering showing that the convection currents which are used in the thermostatization system, do not produce general distortions in the useful volume of the chamber.

539.1.07

2466 USE OF THE FOUR-INCH LIQUID HYDROGEN BUBBLE CHAMBER AS A FAST-NEUTRON SPECTROMETER.
H.E.Adelson, H.A.Bostick, B.J.Moyer and C.N.Waddell.
Rev. sci. Instrum., Vol. 31, No. 1, 1-10 (Jan., 1960).

The bubble chamber has been used in the 5 to 30 MeV region. A fast data-reduction system for the analysis of the recoil-proton tracks was developed, utilizing a commercial electronic coordinate-measuring device, the IBM punch-card system, and the IBM 650 digital computer. The resolution of the entire spectrometer system was determined by measuring the monoergic (14.1 MeV) neutron spectrum from the $t(d,n)He^4$ reaction with different neutron collimators. The full width at half maximum of the measured peak was 10% of the peak energy.

539.1.07

2467 MOMENTUM ESTIMATE FROM MAGNETIC CURVATURE IN DISTORTED EMULSIONS. G.Bellettini.
Rev. sci. Instrum., Vol. 30, No. 10, 899-901 (Oct., 1959).

Kim's analysis (Abstr. 514 of 1959) of the precision obtainable in momentum measurements from the curvature of the tracks in an emulsion placed in a pulsed magnetic field is furthered taking into account the distortion of the plates. Calculations show that one cannot hope to reach a decisive improvement from a pulsed magnetic field, if the distortion of the plates is not reduced somewhat below present-day values. The use of thicker emulsions is suggested as a possible way of improving the situation.

539.1.07

2468 INHIBITION OF SHRINKAGE IN NUCLEAR EMULSIONS.
P.N.Krishnamoorthy.
Proc. Indian Acad Sci. A, Vol.65, No.5, 327-35 (May, 1957).

A method of inhibiting shrinkage in nuclear emulsions has been developed. It consists of replacing the silver halide in the emulsion, which is removed during the fixing stage of the processing, by canada balsam. This method can be employed with advantage in the study of neutron spectra with nuclear emulsions, as it will yield improved energy resolution. Another field in which this process of shrinkage inhibition can be advantageously employed is the study of gamma ray spectra, with heavy water loaded emulsions. Here again, improved energy resolution is possible. In fact, this technique can be employed with advantage in all nuclear emulsion work, as it will (a) result in overall reduction of distortion in emulsions, (b) improve conditions for the measurement of tracks, and (c) improve the stability and keeping qualities if processed emulsions.

539.1.07 : 77

2469 THE MEASUREMENT OF IONIZATION IN PHOTOGRAPHIC EMULSIONS. M.Blau.
Acta phys. Austriaca, Vol. 12, No. 4, 336-55 (1959). In German.

The importance of the correct choice of parameters in the measurement of ionization of particles over the entire available en energy range is discussed. Past work in the field is reviewed and the agreement of the models of grain formation usually employed compared with experimental evidence. It is shown that the parameters currently in use are satisfactory over parts of the energy range only and an attempt is made to replace them with more suitable quantities. The validity of the exponential relation between the gap and blob lengths at low particle energies is questioned. The variation of the mean blob length Λ with the blob density $B(l_1)$ for blobs of length $\geq l_1$ for a number of different energies is studied with a semi-automatic counting device. To date no conclusive evidence for the superiority of these parameters is yet available. S.J.St-Lorant

539.1.07 : 621.374.32

2470 FAST COINCIDENCE CIRCUIT FOR SLOW PULSES.
J.E.Draper and A.A.Fleischer.
Rev. sci. Instrum., Vol. 31, No. 1, 49-52 (Jan., 1960).

A circuit is described which permits the timing of slow pulses (e.g., 300-mμsec rise time) to good precision (e.g., ± 3 mμsec) over a wide range of pulse heights (e.g., 6 V to 120 V) and at high counting rates (average separation > ~ 4 μsec). This is useful particularly in coincidence spectroscopy with NaI(Tl) scintillators.

539.1.07 : 621.374.4

2471 TIME-TO-PULSE HEIGHT CONVERTER OF WIDE RANGE. J.Fischer and A.Lundby.
Rev. sci. Instrum., Vol. 31, No. 1, 10-14 (Jan., 1960).

A time-to-pulse height converter covering the range from millimicroseconds to minutes is described. A simple 5-component passive circuit for scanning times above 50 μsec is included also. The converters can measure several events per time scan related to one starting event. They are designed as plug-in units for an oscilloscope, and utilize its sweep and other circuits. The use of the converters is discussed and includes scanning of negative time and inverted operation for reduction of counting losses. Notes on testing, calibration, and dead times are given, as well as examples of nuclear experiments to which they have been applied.

539.1.07 : 621.374.35

2472 MILLIMICROSECOND DISCRIMINATOR.
D.F.Swift and V.Perez-Mendez.
Rev. sci. Instrum., Vol. 30, No. 11, 1004-6 (Nov., 1959).

A discriminator circuit for use with millimicrosecond counting equipment is described. The circuit utilizes a diode voltage comparator which drives a secondary-emission tube univibrator after amplification. Two shaped outputs are provided: one, of short duration, for use with 10 Mc/s scalers, and another longer pulse for microsecond scalers. The main characteristics of this unit are its good response to pulses as short as 3 mμsec and the fast recovery time, which is less than 0.1 μsec at the fast output.

539.1.07 : 621.375.2 : 621.374.32

2473 A NON OVERLOAD LINEAR AMPLIFIER FOR SCINTILLATION AND PROPORTIONAL COUNTERS.
C.Cottini, E.Gatti and E.Zaglio.
Energia nucleare, Vol. 6, No. 9, 588-94 (Sept., 1959).

A high accuracy non-overload amplifier, particularly suited to gamma-ray spectroscopy, is described. Very high counting rates are permissible without distortion of the spectra.

539.1.07

2474 ELECTRONICS FOR RADIATION DETECTION. IV. MULTICHANNEL ANALYSERS. F.H.Wells.
Nuclear Pwr, Vol. 5, 123-7 (Feb., 1960).

For previous parts see Nuclear Pwr, Vol. 4, 95 (Sept.); 92 (Oct.); 109 (Nov., 1959). After starting the electronic problem of studying nuclear events with a wide range of energy levels and discussing the accuracy required in pulse sorting circuits, the author considers the design principles of instruments for pulse amplitude recording. These include multichannel amplitude discriminators, and recorders using pulse amplitude to digital sorting circuits such as the Hutchinson–Scarrott 100 channel analyser and Wilkinson type analysers. He goes on to discuss the more complex instruments for pulse time recording and their use in measuring neutron energy by time-of-flight methods. Finally he describes the use of magnetic tape in multispectrum recorders, and the applications of time-to amplitude converters to measurement of high neutron energies.

539.1.07

2475 LINEARLY BIASED TRACK COUNTING IN CROSS-SECTION DETERMINATIONS. F.S.Crawford, Jr.
Rev. sci. Instrum., Vol. 30, No. 12, 1096-7 (Dec., 1959).

In determining the average number $\bar{n}$ of tracks per bubble chamber picture, for purposes of determining cross-sections, one usually cannot count all tracks, but counts tracks in only some of the pictures, selected at random. An alternative procedure is described here in which the pictures are not selected at random, but are those which contain the "interesting events". The average of $1/n$ over this "linearly biased" sample equals $1/\bar{n}$, where $\bar{n}$ is the desired average over a random sample. The linear-bias method has some advantages that are complementary to those of the usual random method.

539.1.07 : 539.12

2476 TWOFOLD PULSING OF VAN DE GRAAFF BEAMS FOR TIME-OF-FLIGHT MEASUREMENTS.

H.W.Lewis, P.R.Bevington, W.W.Rolland, R.L.Rummel and R.M.Wilenzick.
Rev. sci. Instrum., Vol. 30, No. 10, 923-4 (Oct., 1959).

A system has been developed which combines pre- and post-acceleration pulsing of the beam from a Van de Graaff accelerator. It has the advantages of low belt charge for a given target current, low background at the detector, and high time resolution. The internal pulser operates at a frequency of 5 Mc/s and produces bursts 5-10 mμsec long. The external pulser is driven sinusoidally by amplifying the pulses from a pick-up loop with a tuned 5 Mc/s amplifier containing a phase shifter. Synchronization can be accomplished with peak beam currents at the pick-up loop as small as 10μa. The sinusoidal signal at the external pulser is used as the timing reference signal to a Los Alamos time-to-pulse height converter. The burst duration at the target is determined by the amplitude of the sweep voltage applied to the external pulser.

539.1.07 : 537.311 : 539.2

GERMANIUM AND SILICON SURFACE BARRIER DIODES AS ALPHA-PARTICLE SPECTROMETERS. See Abstr. 1644

539.1.07

2477 LIQUID HYDROGEN TARGETS OF ADHESIVE-BONDED MYLAR PLASTIC.
R.S.Hickman, R.W.Kenney, R.C.Mathewson and R.A.Perkins.
Rev. sci. Instrum., Vol. 30, No. 11, 983-5 (Nov., 1959).

Vacuum-tight cryogenic containers can easily be made from Mylar plastic sheet and metal, or from Mylar alone, for use in vacuum-insulated liquid hydrogen target assemblies. Mylar is bonded very firmly to metals or to itself by an Epon-Versamid mixture or by Armstrong A-4. These adhesives maintain strong vacuum-tight joints throughout the temperature range from 300 to 4°K. Mylar sheet has also proved satisfactory as vacuum-window material for beam ports. Fabrication of these structures is described in detail, and explosion safety measures are mentioned. Some examples are given of structures which have been used or tested, with data on the ultimate strength of each expressed as the internal pressure required to rupture it. Helium leak testing must be carried out at 77°K or below, because Mylar is relatively impermeable to helium only at low temperatures. The primary electron beams commonly obtained from electron linear accelerators are sufficiently intense to cause Mylar beam windows to fail under vacuum loading, probably because of radiation damage. However, the authors know of no case of radiation damage to Mylar sustained in exposure to secondary beams from high-energy accelerators.

NUCLEAR FIELD THEORY

539.11

2478 WIGHTMAN FUNCTIONS AND THE JACOBI IDENTITY. P.Gulmanelli and E.Montaldi.
Nuovo Cimento, Vol. 13, No. 6, 1276-8 (Sept. 16, 1959).

It is shown how the Dyson integral representation for the double commutator of three scalar fields can be re-expressed in a form in which the condition that the Jacobi identity is satisfied is easily expressed in terms of symmetry requirements on the weight function determining the representation. R.F.Peierls

539.11

2479 CLEBSCH–GORDAN EXPANSION FOR INFINITE-DIMENSIONAL REPRESENTATIONS OF THE LORENTZ GROUP. A.Z.Dolginov and I.N.Toptygin.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 794-6 (Sept., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 3, 550-1 (March, 1959).

This expansion is obtained from a formula in a previous paper by one of the authors (Abstr. 7133 of 1956). W.A.Hepner

539.11

2480 REMARKS ON THE COVARIANT HAMILTONIAN FORMALISM FOR VECTORIAL FIELDS. R.S.Liotta.
Nuovo Cimento, Vol. 14, No. 2, 443-7 (Oct. 16, 1959).

This paper is an extension of previous work by the author (Abstr. 4186 of 1956; 6622 of 1958; 13000 of 1959) on a covariant Hamiltonian formalism of field theory. Difficulties arise when this formalism is applied to vector fields, owing to the fact that the usual equations for the canonical momenta do not, in this case, enable one to define a Hamiltonian function of the field operators and their canonical conjugates. It is shown how this difficulty can be circumvented. E.J.Squires

539.11

2481 POLARIZATION AND TIME REVERSAL INVARIANCE IN STRONG INTERACTIONS. P.Stichel.
Z. Phys., Vol. 157, No. 1, 89-97 (1959). In German.

The Satchler theorem (Abstr. 1647 of 1959) is generalized in a relativistic covariant manner.

539.11

2482 A SOLUBLE MODEL IN FIELD THEORY. I. E.Kazes.
Nuovo Cimento, Vol. 14, No. 4, 815-26 (Nov. 16, 1959).

The Lee model is modified by giving the V-particle a more complicated structure, and still leaving the $\mathcal{N}-\theta$ scattering amplitude exactly soluble. This modification also yields a wider variety of soluble processes. The same limitation that applies to the cut-off size in the Lee model is reproduced in this model. The calculation is performed by using the Hamiltonian formalism as well as dispersion methods.

539.11

2483 RENORMALIZATION OF A PARITY NON-CONSERVING THEORY. C.H.Albright, R.Haag and S.B.Treiman.
Nuovo Cimento, Vol. 13, No. 6, 1282-4 (Sept. 16, 1959).

Criticism of a paper by Sekine (Abstr. 3121 of 1959), who concluded that a certain parity non-conserving theory could not be renormalized. This conclusion is reversed. R.J.N.Phillips

539.11

2484 VERIFYING PARITY CONSERVATION IN STRONG INTERACTIONS BY MEANS OF $\beta-\gamma$ ANGULAR CORRELATION AND $\gamma-\gamma$ CORRELATION. L.Krüger.
Z. Phys., Vol. 157, No. 3, 369-83 (1959). In German.

It is shown that beta–gamma directional correlations provide a means to test parity conservation in the nucleon–nucleon interaction. A parity nonconservation would lead to an asymmetry of the correlation relative to 90° and proportional to RF in magnitude. In this product F signifies the relative amplitude of the wave-function of "wrong" parity in a nuclear state and R a matrix element factor. Some examples are discussed numerically; estimates of an upper limit for F^2 of about 10^{-9} seem possible in suitable experimental cases. The use of gamma–circular gamma correlations as a means of testing parity conservation in nuclear states is briefly reviewed.

539.11

2485 ON LARGE ANGLE PAIR PRODUCTION AND THE LIMITS OF VALIDITY OF ELECTRODYNAMICS.
G.Poiani and I.Reina.
Nuovo Cimento, Vol. 13, No. 6, 1302-5 (Sept. 16, 1959).

The ratio of the pair production cross-section, in the neighbourhood of a proton, at different angles is independent of the proton form-factor, provided the angles are such that the momentum transfer to the proton is constant. Thus, measurements of this ratio should provide a sensitive means of detecting deviations from quantum electrodynamics. As an example, the effects on the cross-section of a specific deviation from quantum electrodynamics are shown. E.J.Squires

539.11

2486 SOME CONSEQUENCES FOR QUANTUM ELECTRODYNAMICS OF AN ESSENTIAL SINGULARITY AT $\alpha = 0$. P.J.Redmond.
Nuovo Cimento, Vol. 14, No. 4, 771-7 (Nov. 16, 1959).

Many authors have suggested that the functions of relativistic field theories are singular in the region of vanishing coupling constant. It is only by virtue of such an assumption that one can hope to reconcile the optimistic attitude that such theories might be mathematically meaningful with the contrary evidence provided by perturbation theory. Once the possibility of such a singularity is allowed many proofs concerning the behaviour of field theories become suspect. As an illustration the argument of Gell-Mann and Low concerning the behaviour of quantum electrodynamics at small distances is re-examined. Within the context outlined above much weaker restrictions are found than those indicated in the original

paper. If an approximation to the photon propagator is calculated by summing a selected infinite set of contributions to the spectral density function, the resulting expression has an essential singularity at $\alpha = 0$, it is not of the form predicted by Gell-Mann and Low, but it does satisfy the weaker conditions discussed in this paper.

539.11

2487 CRITICAL STUDY AND SIMPLIFIED SOLUBLE FORM OF TOMONAGA'S INTERMEDIATE COUPLING APPROXIMATION. J.Mandelbrojt.

Nuovo Cimento, Vol. 14, No. 3, 625-36 (Nov. 1, 1959). In French.

A necessary and sufficient condition is derived for the Tomonaga approximation to give the true nucleon ground state for an arbitrary value of the coupling constant f. A simplified form of the intermediate coupling approximation is introduced which has an exact analytic solution. As $f \to 0$ this approaches the true ground state like the Tomonaga approximation. For large f it approaches the Tomonaga approximation like $1/f^2$ while the latter approaches the true ground state like $1/f$. R.F.Peierls

539.11 : 539.17

2488 ON THE PROBLEM OF TESTING THE INVARIANCE OF AN INTERACTION UNDER TIME REVERSAL. L.I.Lapidus.

Zh. eksper. teor. Fiz., Vol. 35, No. 6(12), 1580-1 (Dec., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 6, 1105-6 (June, 1959).

Direct experimental tests are pointed out for strong interactions based on the relations between asymmetry and polarization phenomena in inverse nuclear reactions. W.A.Hepner

539.11

2489 EQUATIONS OF MOTION FOR RENORMALIZED FIELDS. F.L.Scarf.

Nuovo Cimento, Vol. 14, No. 4, 849-55 (Nov. 16, 1959).

Solutions to conventional equations of motion are generally well-defined only in the "wrong" Hilbert space with all antiparticle states filled. The meaningful quantity which can be renormalized is a Wick product of some functional of the physical particle operators. When the field theory has infinite wave-function renormalization, there is no direct connection between the two representations for the field operators. An example is given for which the two forms have different space-time developments.

539.11

2490 ABOUT THE CONCEPT OF PARTICLE IN QUANTUM FIELD THEORY. P.G.O.Freund.

Nuovo Cimento, Vol. 14, No. 4, 673-80 (Nov. 16, 1959).

Since the infinite vacuum fluctuations of the quantized fields are due to the fact that the particle number operators do not commute with the field operators, in order to eliminate such actually infinite fluctuations, non commutativity of particle number operators corresponding to particles of different sorts is admitted and thus automatically states with determined numbers of particles of various sorts are physically impossible. This leads to a non-canonical quantization which is investigated. It is shown that in the case of non-canonical quantization the elementary oscillators of the field are not dependent but coupled and that a cut-off automatically appears in the Green function which thus appears entirely regular. It also results that the concept of a particle has no physical meaning.

539.11

2491 WAVE SOLUTIONS OF NONLINEAR GENERALIZATIONS OF RELATIVISTIC INVARIANT EQUATIONS [FOR FUNDAMENTAL PARTICLES]. D.F.Kurdgelaidze.

Zh. eksper. teor. Fiz., Vol. 35, No. 6(12), 1572-3 (Dec., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 6, 1099 (June, 1959).

The method developed by the author for the nonlinear spinor equation ($D_{1/2}$) (see Abstr. 2149 of 1958) can also be applied to the equations for the higher-rank spinors obtained for the direct products ($D_{1/2} \times D_{1/2}$) etc. W.A.Hepner

539.11

2492 CONTRIBUTION TO THE THEORY OF BOSONS AND FERMIONS WITH ORIENTED SPINS. A.A.Sokolov and Yu.M.Loskutov.

Ann. Phys. (Leipzig), Folge 7, Vol. 5, No. 1-2, 42-52 (1959).

A theory is developed for positive and negative energy charged bosons and fermions with spins directed oppositely with respect to the corresponding momenta. Invariance of the equations for a fixed spin direction is investigated.

539.11

2493 NONLOCAL EFFECTS IN WEAK INTERACTIONS OF FERMIONS. S.G.Matinyan.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 791-3 (Sept., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 548-9 (March, 1959).

Firstly, Lee and Yang's (Abstr. 1860 of 1958) ideas are applied to muon capture. Secondly, assuming a universal Fermi interaction, comparison of the muon lifetime with nuclear beta-decay yields an upper limit on the radius of the nonlocal interaction. J.C.Taylor

539.11

2494 ON THE MULTIPLE INTERACTION IN QUANTUM FIELD THEORY. L.I.Podlubnyi.

Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1044-5 (Oct., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 4, 728-9 (April, 1959).

Claims to derive a closed form for the potential between two particles, due to the multiple exchange of virtual quanta. R.J.N.Phillips

539.11

2495 A NOVEL DISPERSION RELATION FOR POTENTIAL SCATTERING. A.Klein and B.W.Lee.

Nuovo Cimento, Vol. 14, No. 4, 856-71 (Nov. 16, 1959).

A dispersion relation for potential scattering is found which holds without restriction on momentum transfer. The price paid for this achievement is that the integral in the relation involves a completely non-physical amplitude. Nevertheless it is shown that in combination with the unitarity condition, the Born series, in the event it converges, is completely determined. The transition to the more customary relation is also carried through.

539.11

2496 UPPER BOUNDS ON SCATTERING LENGTHS FOR STATIC POTENTIALS. L.Spruch and L.Rosenberg.

Phys. Rev., Vol. 116, No. 4, 1034-40 (Nov. 15, 1959).

It is shown that in the zero-energy scattering of a particle by a centre of force, where no bound state exists, the Kohn variational principle provides an upper bound on the scattering length. A bound may also be obtained from Hulthen's method, although with the same form of trial function the Kohn result will be lower (and therefore better) than the one obtained from the Hulthen principle. The Rubinow formulation need not provide a bound; for those calculations which have been performed in this form, the results may be converted without any further calculations so that they correspond to the Kohn form, and therefore, under the circumstances considered, do give a bound. Analogous results hold for states of nonzero orbital angular momentum. Direct generalization of the above results are valid for scattering by a compound system.

539.11

2497 ON A FUNCTIONAL RELATION IN QUANTUM MECHANICS. D.A.Kirshnits.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1037-9 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 717-19 (Oct., 1958).

A general theorem concerning the density ρ of non-interacting particles in an external potential field is discussed. It is useful in deriving and checking the correctness of approximate expressions for ρ. Some examples are given. P.M.Davidson

539.11

2498 REMARKS ON A NOTE BY F.S.LOS' "PHASE OF A SCATTERED WAVE". V.V.Malyarov.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1039-40 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 719 (Oct., 1958).

Errors in Los' work (Abstr. 1817 of 1958) are pointed out and it is suggested that it does not contribute usefully to the theory of scattering. R.J.N.Phillips

539.11

2499 ON THE ANALYTIC PROPERTIES OF PARTIAL WAVE SCATTERING AMPLITUDES OBTAINED FROM THE SCHRÖDINGER EQUATION. A.Martin.

Nuovo Cimento, Vol. 14, No. 2, 403-25 (Oct. 16, 1959).

The behaviour of the radial wave equation is studied, for complex momenta. Known results for finite-range potentials are recovered. Infinite range potentials decreasing faster than some exponential are then considered, for S-waves only; properties are found which lead to some dispersion relations. Two examples are treated: an oscillating potential and a family generalizing the Yukawa potential. R.J.N.Phillips

539.11 : 530.16

THE INITIAL-VALUE PROBLEM OF DECAYING STATES.
See Abstr. 2140

ELEMENTARY PARTICLES

539.12

2500 SPECTRAL AND ANGULAR DISTRIBUTION OF CYCLOTRON RADIATION EMITTED BY COLLIDING PARTICLES. L.Oster.

Phys. Rev., Vol. 116, No. 3, 474-80 (Nov. 1, 1959).

An attempt is made to describe the cyclotron radiation of colliding particles in close analogy to optical theory of line formation. If the velocities are small compared with the velocity of light and the collision frequency is not too high, simple expressions are derived for the frequency and angular distribution of the radiation in terms of the basic physical properties of the plasma, such as temperature, density, and collision parameters.

539.12

2501 ON THE GÜRSEY BARYON EQUATION. V.Amar and M.Pauri.

Nuovo Cimento, Vol. 13, No. 6, 1290-3 (Sept. 16, 1959).

A procedure is given for introducing electromagnetic interactions into the Gursey eight component spinor equation, describing baryon doublets, without destroying the connection between the Pauli transformation and charge independence. E.J.Squires

539.12

2502 BETA DECAY OF SPIN-3/2 PARTICLES. R.A.Asanov.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 796-8 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 552-3 (March, 1959).

The electron–neutrino angular correlation and the electron energy spectrum are calculated, using an analogue of the V and A interaction. J.C.Taylor

539.12 : 530.12

2503 ON THE QUESTION OF ANTIGRAVITATION. Yu.A.Aleksandrov, V.N.Andreev and I.I.Bondarenko.

Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1305-6(Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol.35(8), No.5, 911-12 (May, 1959).

It is suggested that existing theories and experimental results demand positive inertial mass for antiparticles. Attention is briefly drawn to difficulties associated with the hypothesis of negative gravitational mass. R.A.Newing

539.12

2504 ON THE DETERMINATION OF THE RELATIVE PARITIES OF ELEMENTARY PARTICLES. Chzou Guan-Chzhao [Chou Kuang-Chao].

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1027-8 (April, 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 710-11 (Oct., 1958).

Experiments involving polarized incident particles are suggested. P.K.Kabir

539.12

2505 THE RADIATION FROM A CHARGED PARTICLE PASSING THROUGH A PLATE. H.M.Garibyan and G.A.Chalikyan.

Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1282-3 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 5, 894-5 (May, 1959).

The method of an earlier paper (Abstr. 5969 of 1958) is applied to the problem of a particle traversing a dielectric plate. W.A.Hepner

539.12

2506 ON THE QUESTION OF THE UNIQUENESS OF PHASE ANALYSIS. L.G.Zastavenko.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 785-7 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 544-5 (March, 1959).

Minami (Abstr. 8914 of 1954) described a transformation of the scattering matrix which leaves the cross-section invariant. This transformation is extended here to scattering of higher-spin particles. J.C.Taylor

539.12

2507 SELECTION RULES IN REACTIONS INVOLVING POLARIZED PARTICLES. Chzhou Guan-Chzhao [Chou Kuang-Chao].

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 783-5 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 543-4 (March, 1959).

The selection rules are consequences of parity conservation for reactions of the form $a + b \rightarrow c + d$, possibly followed by $c + e \rightarrow f + g$. J.C.Taylor

539.12

2508 THE SCATTERING OF SPIN 3/2 PARTICLES BY A COULOMB FIELD. A.A.Komar.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 806-7 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 559-60 (March, 1959).

539.12

2509 THE SCATTERING OF SPIN-2 PARTICLES BY A COULOMB FIELD. A.I.Bedritskii.

Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1278-80 (Nov., 1958).
In Russian. English translation in: Soviet Physics —JETP (New York), Vol.35(8), No.5, 892-3 (May, 1959).

The differential elastic cross-section for relativistic particles is calculated to the lowest order. The effect of screening is also given. R.J.N.Phillips

Photons

539.12

2510 DECAY OF A PHOTON INTO TWO PHOTONS IN A HOMOGENEOUS MAGNETIC FIELD. V.G.Skobov.

Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1315-17 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol.35(8), No.5, 919 (May, 1959).

The probability for this process is calculated, using Schwinger's expression for the Green's function of an electron in the presence of a weak constant external electromagnetic field. J.C.Taylor

539.12

2511 ENERGY LOSS SPECTRA FOR GAMMA RAYS IN NaI. W.F.Miller and W.J.Snow.

Rev. sci. Instrum., Vol. 31, No. 1, 39-46 (Jan., 1960).

Energy loss spectra for gamma rays incident on sodium iodide crystals have been calculated by the Monte Carlo method. The calculations have been carried out for point sources, disk sources, and broad parallel beams of mono-energetic gamma rays varying in energy from 0.279 to 8 MeV. The crystals considered were right circular cylinders varying from small crystals of height and diameter 1 inch to large crystals of height and diameter 6 inches. Also calculated simultaneously with the energy loss spectra were the efficiencies and total absorption fractions.

539.12

2512 GAMMA-RAY PINHOLE TELEVISION CAMERA. A.E.Cohen.

Rev. sci. Instrum., Vol. 31, No. 1, 29-31 (Jan., 1960).

An experimental camera has been devised capable of viewing a γ-ray or X-ray source both statically and dynamically with a kinescope readout suitable for quantitative measurements. Experiments are described indicating sensitivities to X-rays of about 1 to 2 r/hr.

539.12 : 539.18

2513 SAUTER THEORY OF THE PHOTOELECTRIC EFFECT U.Fano, K.W.McVoy and J.R.Albers.
Phys. Rev., Vol. 116, No. 5, 1147-56 (Dec. 1, 1959).

Sauter's results Abstr. 3209(1931); 1364(1932) are expressed in the form of a transition matrix which determines the photoelectric effect cross-section for arbitrary X-ray polarization and arbitrary initial and final orientations of the electron spin. The structure of the matrix elements accounts for curious properties of the cross-section in terms of interference between orbital and spin currents. Expansion of the wave functions into powers of Z/137 simplifies the calculation of the transition matrix, reduces it to a special case of the bremsstrahlung theory in Born approximation, and explains discrepancies between results of earlier calculations. Analytical and graphical data are given on the photoemission of polarized electrons by circularly polarized X-rays. (See also following three abstracts).

539.12

2514 HIGH-FREQUENCY LIMIT OF BREMSSTRAHLUNG IN THE SAUTER APPROXIMATION. U.Fano.
Phys. Rev., Vol. 116, No. 5, 1156-8 (Dec. 1, 1959).

The expansion in powers of Z/137 utilized in the Sauter theory of the photoelectric effect yields a nonzero cross-section proportional to Z^3 at the high-frequency limit of the bremsstrahlung spectrum, and also at the low electron energy limit of the pair production spectrum. These cross-sections are related to the Sauter photoelectric cross-section by detailed balancing. The results apply equally when the effects of spin orientations and X-ray polarization are considered.

539.12

2515 INTERFERENCE OF ORBITAL AND SPIN CURRENTS IN BREMSSTRAHLUNG AND PHOTOELECTRIC EFFECT. U.Fano, K.W.McVoy and J.R.Albers.
Phys. Rev., Vol. 116, No. 5, 1159-67 (Dec. 1, 1959).

The matrix elements of the Born approximation theory of bremsstrahlung are resolved into sums of terms classified according to whether the radiation interacts with orbital or with spin currents and on the basis of additional spin effects which result from electron motion before and after the emission. Observable features of angular distribution, X-ray polarization, and spin orientation can be interpreted as effects of interference between the separate terms. The results are applicable to corresponding features of the photoelectric effect.

539.12

2516 BREMSSTRAHLUNG AND THE PHOTOELECTRIC EFFECT AS INVERSE PROCESSES. K.W.McVoy and U.Fano.
Phys. Rev., Vol. 116, No. 5, 1168-84 (Dec. 1, 1959).

The bremsstrahlung matrix element at the short-wavelength limit of the spectrum is calculated to lowest order in $\alpha = Z/137$, for an unscreened Coulomb field. The result, valid for relativistic incoming electrons, is shown to be exactly $\alpha^{-1}m^{-1}$ times the complex conjugate of Sauter's relativistic matrix element for the K-shell photoelectric effect. These matrix elements are the leading terms in an expansion of the exact matrix elements in powers of α, and they are found to be derivable from the first two terms of the expansions in powers of α of the electron wave-functions. In this sense their structure is completely analogous to that of the Bethe–Heitler bremsstrahlung matrix element. This simple relation between the matrix elements derives from an approximate equality (through first order in α) between the Coulomb wave-functions for bound and zero-momentum continuum states, which can be understood as due to the neglect of the Coulomb binding energy, a second-order quantity in α. Finally, the range of validity of Sauter's approximation is examined in detail. The lower bound of this (energy) range is found to be simply related to the radius of convergence of the expansion of the photoeffect matrix element in powers of α.

539.12 : 537.54

2517 LITHIUM HYDRIDE BREMSSTRAHLUNG BEAM "HARDENER". E.L.Hart and D.H.White.
Rev. sci. Instrum., Vol. 31, No. 1, 33-5 (Jan., 1960).

The attenuation of the low energy component (below 50 MeV) of the bremsstrahlung beam of a high energy electron accelerator by several low-Z absorbers is studied. In particular, the advantages and construction of a lithium hydride absorber are described. The experimentally measured attenuation is compared with that calculated from a single interaction model, and several further suggestions are offered.

539.12

2518 INTERNAL BREMSSTRAHLUNG AND AUTOIONIZATION LINES OF Y^{90} AND P^{32} IN LOW ENERGY RANGE. G.A.Renard.
J. Phys. Radium, Vol. 18, No. 12, 681-6 (Dec., 1957). In French.

Measurements, by proportional counting, of shape and intensity of the internal bremsstrahlung of Y^{90} from (~ 2 to ~ 40 keV), and intensity of K and L rays following autoionization are reported. A method of calibration of the efficiency of the counter by X-rays is described. The new values of efficiency are applied to earlier results obtained with P^{32}. The shape and intensity of the spectrum does not agree with the spectrum theory, but data concerning autoionization correspond fairly well with Levinger's calculations, although for these energies the method is rather uncertain.

539.12

2519 RADIATION OF A MULTILEVEL SYSTEM MOVING IN A MEDIUM WITH A VELOCITY GREATER THAN THE VELOCITY OF LIGHT. V.L.Ginzburg and V.M.Fain.
Zh. eksper. teor. Fiz., Vol.35, No.3(9), 817-18 (Sept., 1958). In Russian. English translation in: Soviet Physics—JETP (New York, Vol.35(8), No.3, 567-8 (March, 1959).

539.12

2520 RADIATION PRODUCED BY AN ELECTRON BEAM PASSING THROUGH A DIELECTRIC MEDIUM. J.Neufeld.
Phys. Rev., Vol. 116, No. 4, 785-7 (Nov. 15, 1959).

An electron beam passing through a dielectric medium may produce an instability that is associated with the growth of longitudinal waves having a velocity close to the velocity of the beam. For a transparent dielectric medium this instability occurs if the frequency ω of these waves satifies the following condition: $\omega_1^2 < \omega^2 < \omega_1^2 + \omega_0^2$, where ω_1 is the frequency of bound oscillators in the dielectric medium and $\omega_0 = (4\pi ne^2/m)^{1/2}$, where n is the electron density. If inhomogeneities are present these longitudinal waves may be converted into transverse waves and radiated into space Thus, there is a possibility of a luminous effect at "Bohr frequencies" that differ from the Vavilov–Cherenkov frequencies.

539.12

2521 ON A POSSIBLE STATISTICAL DESCRIPTION OF SYSTEMS OF PARTICLES INTERACTING WITH THE FIELD. Yu.L.Klimontovich.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1276-7 (Nov., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 5, 891-2 (May, 1959).

The kinetic equations for systems of electrons and oscillators of the transverse electromagnetic field are set up to investigate the emission of electromagnetic waves by charged particles in dielectrics. Expressions derived agree with those for Cherenkov radiation. J.W.Sturgess

X-rays

539.12

2522 QUANTITATIVE INTERPRETATION OF X-RAY SHADOWS. G.Spiegler.
Z. angew. Phys., Vol. 11, No. 2, 65-8 (Feb., 1959). In German.

A general article on the relation between X-ray absorption and mass per unit area, and its applications. A.R.Stokes

539.12

2523 THE PHYSICAL LIMITATIONS OF GRIDS FOR THE REDUCTION OF SCATTERED X-RADIATION. K.H.Reiss.
Z. angew. Phys., Vol. 11, No. 5, 184-8 (May, 1959). In German.

The ratio of scattered to primary radiation has been measured for a series of grids of different ratio with a water phantom as scattering medium. A geometric theory of grid efficiency is given. The grids examined were less efficient than theory which, in part, is attributed to production of self-scattered and fluorescence radiation in the grid itself. J.R.Mallard

539.12

2524 DETERMINATION OF SPECTRAL CONTAMINATION OF X-RAY TUBES. J.Ladell and W.Parrish.
Philips Res. Rep., Vol. 14, No. 5, 401-20 (Oct., 1959).

An X-ray method is outlined for the qualitative and quantitative

analysis of the spectral purity of X-ray tubes. The method, based on well-known principles, employs a standard diffractometer equipped with a xenon-filled proportional counter and molybdenum-foil analyser. The various theoretical and practical aspects required in the determination of the correction factors to compare different wavelengths are described.

539.12 : 53

NEW METHOD FOR THE EVALUATION OF h/e FROM THE QUANTUM LIMIT OF THE CONTINUOUS X-RAY SPECTRUM. See Abstr. 2094

Neutrinos

539.12

2525 A CONTRIBUTION TO NEUTRINO THEORY. V.V.Chavchanidze and M.E.Perel'man.

Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 296-8 (July, 1958). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 8, 35(8), No. 1, 204-5 (Jan., 1959).

It is suggested that in β-, μ- and π-decays there is emitted a quantum-mechanical mixture of two light neutral Dirac particles of opposite parity, each the antiparticle of the other. E.J.Burge

Electrons

539.12

2526 ON THE THEORY OF THE ELECTRON. V. W.Wessel.

Z. Naturforsch., Vol. 14a, No. 12, 1005-14 (Dec., 1959). In German.

For Pt IV, see Abstr. 4363 (1955). The field dependent terms in the Hamiltonian lead, by means of a variational principle, to a mass operator of the Heisenberg type. L.Pincherle

539.12

2527 NON-LOCAL EFFECTS IN ELECTRON–ELECTRON AND ELECTRON–POSITRON SCATTERING. G.Furlan and G.Peressutti.

Nuovo Cimento, Vol. 14, No. 4, 758-66 (Nov. 16, 1959).

The authors calculate the effect of a modification of the Coulomb law at small distances, on the cross-sections for electron–electron and electron–positron scattering. A detailed analysis shows that the Møller cross-section is less sensitive to non-local effects than the Bhabha cross-section.

539.12

2528 SOME EXPERIMENTAL RESULTS ON THE ANGULAR INTENSITY DISTRIBUTIONS OF BACKSCATTERING AND TRANSMISSION FROM AN ISOTROPIC P^{32} β SOURCE ON THICK AND THIN PLANE SCATTERING MEDIA. W.L.Buys.

Z. Phys., Vol. 157, No. 4, 478-89 (1960).

The P^{32} saturation back-scattering component, named side scattering by Seliger (Abstr. 265 of 1953) is verified and further investigated for thin Al foils in connection with transmission, by means of a simple, small solid-angle Geiger-counter method. Variations occurring in the side scattering angular distribution, due to surface effects, are illustrated. They can explain some errors occurring in absolute beta-counting, and are related to results reported by Kanter (Abstr. 1531 of 1959).

539.12

2529 ON THE STOCHASTIC EQUATION FOR THE ENERGY LOSS OF FAST ELECTRONS IN MATTER. L.Bass.

Proc. Indian Acad. Sci. A, Vol. 45, No. 6, 423-7 (March, 1956).

The integro-differential equation describing the energy distribution of very fast electrons (with negligible collision loss of energy) is reduced to a Volterra integral equation of the second kind. A rigorous solution, for an arbitrarily prescribed boundary condition, is given in terms of a convergent expansion of the Liouville–Neumann type. This method is applicable for transition probabilities of a form which is much more general than the form permitting a successful application of the Mellin transform. Since the reduction of the emission probability for bremsstrahlung to the latter form involves an approximation in a certain region, the present method may be used in order to obtain a higher accuracy in that region.

539.12

2530 APPLICATION OF SUM RULES TO ELECTRON–DEUTERON SCATTERING. J.I.Friedman.

Phys. Rev., Vol. 116, No. 5, 1257-62 (Dec. 1, 1959).

A measurement of elastic and inelastic electron–deuteron scattering was made at a momentum transfer of 206 MeV/c and an electron energy of 175 MeV for comparison with the Drell–Schwartz sum rules (Abstr. 3910 of 1959). The measured value of the non-energy-weighted sum rule is in good agreement with theory. The experimental result for the energy weighted sum rule is 30% larger than the value given for a pure Wigner potential and is consistent with a Rosenfeld two-body interaction if the analysis is restricted to central forces. The analysis is extended to include tensor forces for comparison with the prediction of the Gartenhaus potential. It is found that the gauge terms introduce major ambiguities when tensor forces are included.

539.12 : 539.18

THEORY OF ELECTRON SCATTERING FROM ATOMIC HYDROGEN. See Abstr. 1476

539.12

2531 DIRECT PAIR PRODUCTION BY MUONS. B.P.Roe and S.Ozaki.

Phys. Rev., Vol. 116, No. 4, 1022-7 (Nov. 15, 1959).

The direct pair production cross-section was measured for muon primaries between about 8 and 120 BeV. The muons were selected by a magnetic spectrometer and interactions were observed in a multiplate expansion cloud chamber. Results indicate that in the transferred-energy range above about 200 MeV the direct pair cross-section is somewhat less than that predicted by the Murota–Ueda–Tanaka theory. This result does not, however, necessarily indicate any breakdown of fundamental electromagnetic theory. Possible theoretical inadequacies are discussed in the text.

539.12

2532 ELECTRON–POSITRON PAIRS FROM THE DECAY $\pi^0 \rightarrow e^- + e^+ + \gamma$. Yu.A.Budagov, S.Viktor, V.P.Dzhelepov, P.F.Ermolov and V.I.Moskalev.

Zh. eksper. teor. Fiz., Vol. 35, No. 6(12), 1575-7 (Dec., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 6, 1101-3 (June, 1959).

An experimental determination of the ratio of this process to the decay into two photons is found to be in agreement with theoretical calculations by Dalitz (1951) and by others, as well as with other experimental data. W.A.Hepner

539.12 : 539.2

2533 FORMATION OF POSITRONIUM IN AN ELECTRON GAS. J.Callaway.

Phys. Rev., Vol. 116, No. 5, 1140 (Dec. 1, 1959).

It is shown to be unlikely that a positronium atom, described by a hydrogenic wave-function, can exist in an electron gas of a density corresponding to that found in metals (c.f. Abstr. 7255 of 1959).

Nucleons

539.12

2534 ON THE INTERACTIONS OF THE NUCLEONS. L.Tenaglia.

Nuovo Cimento, Vol. 14, No. 3, 653-5 (Nov. 1, 1959).

Discusses the introduction of electromagnetic, pion and Fermi interactions in an 8-component spinor formalism.

R.J.N.Phillips

539.12

2535 CHARGE DISTRIBUTION OF THE NUCLEON. V.De Alfaro and E.Predazzi.

Nuovo Cimento, Vol. 14, No. 2, 448-51 (Oct. 16, 1959).

The nucleon electromagnetic form factors are calculated on the assumption of a charge distribution consisting of a uniform core with asymptotic behaviour outside it as calculated from dispersion theory. It is found that (at least in the absence of a pion–pion interaction) the experimental results cannot be reproduced; the neutron form factor having the wrong sign and the proton mean square radius being appreciably too large. R.F.Peierls

539.12

2536 INTERACTION OF STATIC NUCLEONS. R.E.Cutkosky.
Phys. Rev., Vol. 116, No. 5, 1272-84 (Dec. 1, 1959).

The Heitler–London method was applied to the calculation of the energy of interaction of two nucleons, as given by the fixed-source model. Numerical results are also given for the normalization of the state vector and the number of mesons in the cloud, for the states which comprise the deuteron. Particular attention is given to the rate of convergence of the expansions and the influence of the excited states of the nucleons. The relation to the Tamm–Dancoff method is also discussed in detail. It is shown that in T = 0 states, the interaction does not appear to differ in any significant way from the one-meson exchange term. In T = 1 states, on the other hand very large contributions are obtained from the higher-order terms. These contributions have such a nature as to suggest that even at low energies it is improper to apply the fixed-source model, with the assumption that the meson cloud follows adiabatically the motion of the nucleons, to T = 1 states.

Protons

539.12

2537 MAGNETIC MOMENT OF THE PROTON IN UNITS OF THE BOHR MAGNETON; THE MAGNETIC MOMENT OF THE ELECTRON. S.Liebes, Jr and P.Franken.
Phys. Rev., Vol. 116, No. 3, 633-50 (Nov. 1, 1959).

The details of a previously reported measurement (Abstr. 3542 of 1957) of the proton magnetic moment in units of the Bohr magneton are given. This ratio of moments, which is obtained from common magnetic field observations of the nuclear magnetic resonance frequency of protons in a spherical sample of mineral oil and the cyclotron frequency of free low-energy electrons, is found to be $\mu_p(\text{oil})/\mu_0 = (657.462 \pm 0.003)^{-1}$, where the uncertainty represents the estimated 50% probable error. The magnetic moment of the free proton is found, upon application of the appropriate diamagnetic correction factor, to be $\mu_p/\mu_0 = (657.442 \pm 0.003)^{-1}$. The present result may be combined with reported values for the ratio of the magnetic moment of the electron to the moment of the proton to yield for the magnetic moment of the free electron in units of the Bohr magneton,

$$\mu_e/\mu_0 = 1.00\,168 \pm 0.000\,005 = 1 + (\alpha/2\pi) + (1.2 \pm 0.9)(\alpha^2/\pi^2),$$

where the uncertainty is the estimated 50% probable error. This result is to be compared with the current theoretically estimated value for this quantity,

$$\mu_e/\mu_0 = 1 + (\alpha/2\pi) - 0.328(\alpha^2/\pi^2) = 1.001\,159\,6.$$

539.12

2538 BREMSSTRAHLUNG AND PAIR PRODUCTION FROM PROTONS WITH ALLOWANCE FOR THE FORM FACTOR. I.Zlatev and P.S.Isaev.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 309-10 (July, 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 8(35), No. 1, 213-15 (Jan., 1959).

These processes are calculated in the lowest-order perturbation theory, using the proton vertex factor taken from Hofstadter's electron scattering experiments, but neglecting a contribution from the meson "jacket". In a no-recoil approximation, the Bethe–Heitler expressions are obtained. Comparison with experiment indicates a measurable contribution from the neglected "jacket" term. D.W.L.Sprung

539.12

2539 APPLICATION OF FIXED ANGLE DISPERSION RELATIONS TO PROTON–PROTON SCATTERING. W.Alles and A.Tomasini.
Nuovo Cimento, Vol. 13, No. 6, 1265-7 (Sept. 16, 1959).

Fixed angle dispersion relations are applied to the case of low energy proton–proton scattering and used to study the relation between the phase shifts and the pion–nucleon coupling constant. Using only the $^1S_0$ state analysis, the result $f^2 = 0.082$ is obtained, in good agreement with other methods. Allowing higher partial waves, the value of f is found to depend strongly on the effective range used. R.F.Peierls

539.12

2540 APPLICATION OF FIXED ANGLE DISPERSION RELATIONS TO NUCLEON–NUCLEON SCATTERING IN THE TRIPLET STATE. W.Alles and A.Tomasini.
Nuovo Cimento, Vol. 13, No. 6, 1273-5 (Sept. 16, 1959).

See preceding abstract. The same method is used to study the triplet state. The results indicate that the coefficient of q^4, in the expansion of $q\cot\delta$, is very probably negative, as predicted by the model of Signell and Marshak. R.F.Peierls

539.12

2541 PROTON ALPHA-PARTICLE SCATTERING AT 20.1 MeV. J.W.Burkig.
Phys. Rev., Vol. 116, No. 3, 674-5 (Nov. 1, 1959).

The differential scattering cross-section for 20.1 MeV (laboratory energy) protons incident on helium gas was measured. The following figures give the centre-of-mass scattering angle in degrees and minutes, and the corresponding cross-section (c.m.) in millibarns per steradian: 8° 42' : 604; 9° 57' : 335; 11° 11' : 262; 12° 25' : 230; 13° 40' : 209; 14° 55' : 204; 16° 8' : 198; 18° 37' : 193; 22° 11' : 198; 24° 51': 195; 31° 6' : 179; 37° 19' : 167; 43° 31' : 143; 49° 45' : 122; 54° 57' : 104; 87° 6' : 42. At c.m. angles of 111° 48' and 161° 30' no scattered particles were detected. The counting statistics varied from about ±1% at the smallest angles to ±2% at 54° 57' (lab angle 45° 0'). The estimated over-all accuracy of the above cross-section is ±4% , with the exception of the 87° 6' figure, which is accurate to about ±10%.

539.12

2542 PROTON–PROTON SCATTERING AT 10 MeV. L.H.Johnston and D.E.Young.
Phys. Rev., Vol. 116, No. 4, 989-91 (Nov. 15, 1959).

Differential cross-sections were measured for scattering of 9.69 MeV protons by hydrogen gas, covering the laboratory angular range from 45° to 5°. The angular resolution was ±½° at small angles, and estimated absolute probable errors ±0.7% except at the smallest angles. The interference minimum of 51.4 mb occurred at 34° c.m. and the 90° cross-section was 54.6 mb. The data can be fit with the following set of phase shifts: $^1S_0 = 54°$, $^3P_0 = +2.83°$, $^3P_1 = -5.07°$, $^3P_2 = +2.22°$, $^1D_2 = +0.2°$.

539.12

2543 MODIFIED ANALYSIS OF NUCLEON–NUCLEON SCATTERING. II. COMPLETED ANALYSIS OF p–p SCATTERING AT 310 MeV. M.H.MacGregor, M.J.Moravcsik and H.P.Stapp.
Phys. Rev., Vol. 116, No. 5, 1248-56 (Dec. 1, 1959).

For Pt I, see Abstr. 9952 (1959). The application of a recently suggested modified method of analysis of nucleon–nucleon scattering experiments to p–p scattering at 310 MeV has been completed. The results are summarized and compared with the work of Gammel and Thaler (Abstr. 7971 of 1957) and of Signell and Marshak (Abstr. 2468 of 1958). The analysis is carried out on several levels, with varying number of angular momentum states being described by phenomenological phase shifts while the higher angular momentum states are represented by the one-pion exchange contribution. It is found that the inclusion of the high angular momentum states in this manner makes a significant improvement in the analysis. The pion–nucleon coupling constant is also determined from the data with a fair accuracy. The five "best" sets of phase shifts of the conventional analysis are reduced to two sets, corresponding to Solution 1 and 2 of the conventional analysis. Some slight evidence favours Solution 1 over Solution 2. It is shown that a very satisfactory fit can be obtained with nine parameters instead of the 14 parameters of the conventional analysis. Some remarks are made about the extent to which Solutions 1 and 2 are distinct. Experiments are suggested which could resolve the remaining ambiguity due to the existence of two sets of phase shifts.

539.12

2544 PROTON–PROTON SCATTERING IN THE $^1D_2$ STATE AT 616 MeV. L.M.Soroko.
Zh. eksper. teor. Fiz., Vol.35, No.1 (7), 276-7 (July, 1958).
In Russian. English translation in: Soviet Physics–JETP (New York) Vol.35(8), No.1, 190 (Jan., 1959).

An analysis of experimental data gives the dependence of the squares of the S-matrix elements on proton energy from 400 to 800 MeV. E.J.Burge

539.12

2545 PROTON–PROTON POLARIZATION AT 16 MeV. W.A.Blanpied.
Phys. Rev., Vol. 116, No. 3, 738-40 (Nov. 1, 1959).

The proton–proton polarization was measured at 16.2 ± 0.2 MeV and 25° in the laboratory system, using the double-scattering method, with hydrogen gas as second scatterer. Instrumental asymmetries were practically eliminated by using carbon and copper alternately as first targets. The polarization was found to be +(0.6 ± 0.5)%. Theoretical implications of the work are discussed.

Neutrons

539.12

2546 MEASUREMENT OF THE HALF-LIFE OF THE NEUTRON. A.N.Sosnovskii, P.E.Spivak, Yu.A.Prokof'ev, I.E.Kutikov and Yu.P.Dobrynin.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1059-61 (Oct., 1958). In Russian. English translation in : Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 739-40 (April, 1959).

An account is given of the experimental method used for the determination of the half-life of neutrons from the RFT reactor. The value obtained was 11.7 ± 0.3 min giving an ft value of 1180 ± 35. By comparison with the ft value of O^{14} it is found that $|g_{GT}/g_F|^2 = 1.42 \pm 0.08$. A.Ashmore

539.12

2547 THE SCATTERING OF SLOW NEUTRONS BY WATER MOLECULES. A.F.Goryunov.
J. nuclear Energy, Vol. 4, No. 1, 109-14 (Jan., 1957). English translation of article in: Atomnaya Energiya, Vol. 1, No. 3, 45 (1956).

The cross-section for scattering of slow ($E_n < 0.19$ eV) neutrons by a water molecule is calculated, using perturbation theory.

539.12

2548 THE SCATTERING OF NEUTRONS BY PARA- AND ORTHO-HYDROGEN. S.I.Drozdov.
J. nuclear Energy, Vol. 4, No. 1, 115-21 (Jan., 1957). English translation of article in: Atomnaya Energiya, Vol. 1, No. 3, 50 (1956).

The differential and total cross-section for elastic and inelastic scattering of neutrons by molecules of para- and ortho-hydrogen are calculated. In addition to the rotational degrees of freedom of the molecule, the vibrations of the nuclei are also taken into account in the harmonic approximation. The mean energy lost by the neutron in exciting the molecule is determined.

539.12 : 539.17

2549 MEASUREMENT OF THE POLARIZATION OF (D + T)-NEUTRONS AT DEUTERON ENERGIES OF 1800 keV. I.I.Levontov, A.V.Miller and V.N.Shamshev.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1030-2 (April, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 712-14 (Oct., 1958).

The method of Galonsky and Johnson (Abstr. 2649 of 1957) was used with a helium proportional counter operating at 8 to 12.5 atmospheres as the neutron detector. The polarization (%) was found to be between 0 ± 5 and 12 ± 3 depending on the angle of emission of the neutrons from the tritium target. E.J.Burge

539.12 : 539.17

2550 NEW MEASUREMENTS OF THE SPECTRUM OF NEUTRONS FORMED ON BOMBARDMENT OF Be BY 680 MeV PROTONS.
V.S.Kiselev, K.O.Oganesyan, R.A.Poze and V.B.Flyagin.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 812-14 (Sept., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 3, 564-5 (March, 1959).

The neutron spectrum at 0° was measured using magnetic analysis of the recoil protons. In this way the charged pion component was removed. The 610 MeV peak has a smaller width (100 MeV) than that given previously. A.Ashmore

539.12 : 621.382 : 621.317.794

2551 A SEMICONDUCTOR DEVICE FOR FAST- AND SLOW-NEUTRON DOSIMETRY. C.A.Klein and W.D.Straub.
Proc. Instn Elect. Engrs, Paper 2986 E [International Convention on Transistors and Associated Semiconductor Devices], Vol. 106B, (Suppl. No. 16, 706-13).

Quantitative observations of pile-neutron effects in germanium and silicon suggest their use as fast-neutron dosimeters, especially in mixed neutron-γ fields. In order to provide a firm basis for such techniques, or in other words, to determine neutron-response characteristics of semiconductor materials for general dosimetry applications, more information is needed on the extent to which the damage is actually energy dependent. In the present state of the art, the development of semiconductor dosimeters for fast neutrons of known energy spectrum should be rewarding. On the other hand, it is well known that thermal-neutron captures by lattice nuclei have only a small effect on the electrical properties of germanium or silicon crystals. Slow-neutron reactions yielding fast charged particles or ions may result in enhanced, highly localized damage of practical interest for thermal-neutron dosimetry. A suitable arrangement combining a high-resitivity p-type germanium foil with thin linings of lithium-6 appears to be a convenient tool for the estimation of biologically significant thermal-neutron doses. Analytical and experimental work done on semiconductor dosimeters designed according to the above-mentioned lines is presented.

539.12

2552 FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. G.C.Neilson, W.K.Dawson and F.A.Johnson.
Rev. sci. Instrum., Vol. 30, No. 11, 963-75 (Nov., 1959).

A versatile neutron time-of-flight spectrometer suitable for use in the millimicrosecond region is described. Either the r.f. beam deflection method or the gamma coincidence method is used to provide the zero time indication. Details of these methods, along with spectra obtained for some (d,n) reactions, are given. The two systems are compatible and make use of the same simple time-to-pulse-height converter. The dependence of the decay time of a liquid scintillator on the specific ionization of the detected particle has been used to make the neutron detector insensitive to gamma-rays.

539.12 : 539.1.07

TWOFOLD PULSING OF VAN DE GRAAFF BEAMS FOR TIME-OF-FLIGHT MEASUREMENTS. See Abstr. 2476

Mesons

539.12

2553 STRANGENESS 2 MESON. T.Yamanouchi.
Phys. Rev. Letters, Vol. 3, No. 10, 480-2 (Nov. 15, 1959).

In a previous publication (Abstr. 374 of 1960), the author and a collaborator described an event which seemed to represent the capture of a singly charged negative particle of strangeness 2 and mass about 700 MeV. The author here analyses a group of seven other anomalous events from various sources which could be interpreted as the same particle, or its positive counterpart (antiparticle) decaying into a K-meson and a π-meson. He concludes that the evidence for such a particle is now difficult to discount. S.J.Goldsack

539.12

2554 ANALYTIC PROPERTIES OF PARTIAL AMPLITUDES IN MESON–NUCLEON SCATTERING. S.W.MacDowell.
Phys. Rev., Vol. 116, No. 3, 774-8 (Nov. 1, 1959).

The analytic properties of partial wave amplitudes in meson-nucleon scattering are investigated on the basis of the Mandelstam representation (Abstr. 4941 of 1959) and an integral representation is set up for them which explicitly exhibits those properties.

539.12

2555 S-STATE MESON–NUCLEON SCATTERING AND MESON–MESON INTERACTION IN FIXED SOURCE THEORY. I. SCATTERING BY THE SOURCE. G.Bonnevay.
Nuovo Cimento, Vol. 14, No. 3, 593-611 (Nov. 1, 1959). In French.

A discussion is given of the values of the S phase shifts given by fixed source theory considered as the limit of the pseudoscalar, charge independent, relativistic theory, the coupling constant being determined by the p-wave scattering. The scattering amplitudes obtained in this way are too large and both have the same sign. They are to be used as the basis of a subsequent calculation taking into account the effects of the scattering of the incident meson by the cloud. R.F.Peierls

539.12

EVALUATION OF DISPERSION RELATIONS.

2556 R.Blankenbecler and S.Gartenhaus.

Phys. Rev., Vol. 116, No. 5, 1297-305 (Dec. 1, 1959).

A new evaluation of the dispersion relations for mesonic phenomena is proposed. The method, which utilizes the comparison function procedure, makes explicit use of crossing symmetry and allows for an exact treatment of nuclear recoils. For the case of meson–nucleon scattering at low energies, an expansion of a first-order solution is made in inverse powers of the nucleon mass and agreement with the results of a previous evaluation (Abstr. 7428 of 1957) is obtained. The extension of the method to other processes is briefly discussed. (See also Abstr. 2584 of 1960).

539.12

PRELIMINARY REMARKS ON THE CONSEQUENCE OF THE TWO-CENTERS MODEL OF MULTIPLE MESON PRODUCTION.

2557 V.Petrášilka.

Nuovo Cimento, Vol. 13, No. 6, 1300-1 (Sept. 16, 1959).

Following the work of Meier (Abstr. 9965 of 1959) and previous work of the author (Abstr. 3736 of 1959), the results of calculations of the Lorentz factors and angles associated with four particular jets are given. E.J.Squires

539.12

MULTIPLE MESON PRODUCTION BY 9 GeV PROTONS ON EMULSION NUCLEI.

2558 E.M.Friedländer.

Nuovo Cimento, Vol. 14, No. 4, 796-814 (Nov. 16, 1959).

300 meson showers with $n_s \geq 4$ produced by 9 GeV protons in an emulsion stack have been analysed as to their multiplicity and angular distributions. It is shown that light and heavy target nuclei can be safely distinguished by the criterion $N_h \leq 4$, $N_h \geq 7$. The kinematical features of the collisions are consistent with emission of the shower particles from a single mass-centre. The c.m.s. angular distribution of the shower particles is proved to be isotropic for all types of collisions. Individual c.m.s. Lorentz factors, γ_c, have been estimated for every event. The distribution of γ_c-values agrees well with the predictions of the tunnel model of nucleon–nucleus collisions. The average tunnel lengths for heavy and light nuclei have been found proportional to the nuclear radii. An excess of very high γ_c and very low γ_c events has been tentatively interpreted as due to peripheric collisions with pions in the meson cloud surrounding the colliding nucleons. The fractional energy transfer to pions is found independent of the target nucleus and equal to ~ 33%. One outgoing particle (at least in some cases a pion) is often observed to carry away a large fraction of the available energy.

539.12

MULTIPLE MESON PRODUCTION IN NUCLEON–NUCLEON INTERACTIONS AT ENERGIES OF 10^{13} eV.

2559 M.Schein, D.M.Haskin, E.Lohrmann and M.W.Teucher.

Phys. Rev., Vol. 116, No. 5, 1238-47 (Dec. 1, 1959).

A nuclear interaction of type 0 + 20p observed in nuclear emulsion was analysed by measuring the energies and angles of the secondary particles. The primary energy, as determined from the angular distribution of the tracks, is 2.7×10^{13} eV. This value is in agreement with an independent estimate obtained from the total energy dissipated. A secondary collision of type 0 + 20n was also analysed in the same way. Its energy is 1.4×10^{13} eV, which is comparable to the primary energy. The inelasticity of the primary event is $0.54_{-0.19}^{+0.19}$. The energy and angular distributions of the shower particles in the centre-of-mass (c.m.) system are given for both events. The shower particles show a correlation in the sense that those with the highest energies are emitted in the c.m. system under small angles with the shower axis. The energy distribution of the mesons in the c.m. system is peaked toward low energies and shows a remarkably long tail at high energies extending up to 10 BeV. One of these particles is a π^0 meson, which carries off about 23% of the total energy. The average value of the transverse momentum of the shower particles is 0.3 ± 0.05 BeV/c.

539.12

μ-MESON DECAY

2560 C.Fronsdal and S.L.Glashow.

Phys. Rev. Letters, Vol. 3, No. 12, 570-1 (Dec. 15, 1959).

A charged scalar intermediate field can generate the V-A form of weak interaction. Using this theory, the branching ratio for the $e + \gamma$ decay mode of a free muon is calculated to be $\alpha/24\pi \cong 10^{-4}$, well above the present experimental upper limit. R.J.N.Phillips

539.12

TRANSFORMATION OF MUONS INTO ELECTRONS.

2561 G.Feinberg, P.Kabir and S.Weinberg.

Phys. Rev. Letters, Vol. 3, No. 11, 527-30 (Dec. 1, 1959).

It is shown that no parity-conserving, renormalizable, gauge and Lorentz invariant interaction between muons, electrons and photons can give rise to the transformation $\mu \rightarrow e + \gamma$. A similar result holds for weak contact interactions between muons and electrons, at least in first order. It is suggested that perhaps two linear combinations of the muon and electron fields are in some sense more fundamental than the fields corresponding to the observed particles. Apart from weak interactions, the Lagrangian in these new fields is symmetrical between them. E.J.Squires

539.12

ON μ-MESON ELECTRON SCATTERING.

2562 B.De Tollis.

Nuovo Cimento, Vol. 14, No. 1, 253-6 (Oct. 1, 1959).

The form factor for μ-meson–electron scattering is calculated on the assumption that the μ is coupled to a neutral, spinless, scalar or pseudoscalar boson. The coupling constant and the mass of the boson are not independant owing to the limits on the μ anomalous magnetic moment. Thus it can be shown that the form factor will not show up in μ–electron scattering, up to an energy of 15 MeV in the electron rest system. E.J.Squires

539.12

CONTRIBUTION OF NUCLEON CURRENTS TO RADIATIVE MUON CAPTURE BY A PROTON.

2563 G.K.Manacher and L.Wolfenstein.

Phys. Rev., Vol. 116, No. 3, 782-4 (Nov. 1, 1959).

The observables for the reaction $\mu^- + p \rightarrow n + \nu + \gamma$ are calculated for a general $(pn\mu\nu)$ coupling including all terms of order (μ/M) and leading terms of order $(\mu/M)^2$, where μ is the meson mass and M the nucleon mass. The nucleon anomalous magnetic moments are handled by the inclusion of a simple Pauli term and all other virtual pion effects are omitted. The (μ/M) terms change the radiative capture rate by as much as 30%. Parity-nonconserving effects are decreased only slightly.

539.12

THE UNIVERSAL FERMI INTERACTION AND CAPTURE OF A μ-MESON BY A PROTON.

2564 Ya.B.Zel'dovich and S.S.Gershtein.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 821-3 (Sept., 1958).
In Russian. English translation in: Soviet Physics–JETP, Vol. 35(8), No. 3, 570-2 (March, 1959).

It is suggested that measurement of the absolute rate of μ-capture from the F=0 hyperfine structure state in hydrogen can discriminate between the couplings V − A and V + A, since the rates differ by a factor of about 4 in the two cases. P.K.Kabir

539.12

THE μ^+-MESON DEPOLARIZATION IN NUCLEAR EMULSIONS WITH DIFFERENT GELATIN CONTENT.

2565 Yu.M.Ivanov and A.I.Fesenko.

Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1297-8 (Nov., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol.35(8), No.5, 905-6 (May, 1959).

The asymmetry coefficient was found to vary from -0.065 ± 0.041 to -0.37 ± 0.06 as the emulsion was diluted with gelatin from the normal content to four times normal. E.J.Burge

539.12

RADIATIVE DECAY OF $\pi^\pm$ MESONS AND EFFECTS OF PARITY NONCONSERVATION.

2566 A.I.Mukhtarov and S.A.Gadzhiev.

Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1283-5 (Nov., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 895-6 (May, 1959).

An expression for the probability of the radiative decay of the pion according to $\pi^\pm \rightarrow \mu^\pm + \nu + \gamma$ is derived from the four-component neutrino theory and is shown to have three parity non-conserving terms. For small muon momenta the analysis indicates that, if the pion decays with the emission of a neutrino, the muon spin must make an angle close to 180° with the direction of the gamma quantum. If an antineutrino is emitted the angle should be close to zero.
E.G.Michaelis

539.14

2567 LIFETIME OF THE FIRST EXCITED STATE OF Mg^{24}. D.G.Alikhazov, A.P.Grinberg, G.M.Gusinskii, K.I.Erokhina and I.Kh.Lemberg.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1056-8 (Oct., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 737-8 (April, 1959).

The Coulomb excitation of the first excited state of Mg^{24} by triply charged nitrogen ions was observed and lifetime of the first excited state is reported to be $1.5 \pm 0.4 \times 10^{-12}$ sec. L.L.Green

539.12

2568 THE $\pi^- - \pi^0$ MASS DIFFERENCE. P.Hillman, W.C.Middelkoop, T.Yamagata and E.Zavattini.
Nuovo Cimento, Vol. 14, No. 4, 887-94 (Nov. 16, 1959).

The time flight of the neutron resulting from the reaction at rest $\pi^- + p \rightarrow \pi^0 + n$ was measured, and from this a value for the $\pi^- - \pi^0$ mass difference of (9.01 ± 0.08) electron masses was obtained.

539.12

2569 PION MASS MEASUREMENTS USING NEUTRON TIME-OF-FLIGHT TECHNIQUES. R.P.Haddock, A.Abashian, K.M.Crowe and J.B.Czirr.
Phys. Rev. Letters, Vol. 3, No. 10, 478-80 (Nov. 15, 1959).

The velocities of the neutrons emitted in the reactions $\pi^- + p \rightarrow \gamma + n$ and $\pi^- + p \rightarrow \pi^0 + n$ are very sensitive to the π^- mass and the π^-, π^0 mass difference respectively. Direct neutron time of flight measurements are described over flight paths of about 12 and 17 ft. The results for π^- mass are (272.4 ± 1.1) m_e, in good agreement with, though less accurate than the accepted value. The value obtained for the mass difference is 8.991 ± 0.020, an order of magnitude more accurate than previous methods. S.J.Goldsack

539.12

2570 PARITY OF THE NEUTRAL PION. R.Piano, A.Prodell, N.Samios, M.Schwartz and J.Steinberger.
Phys. Rev. Letters, Vol. 3, No. 11, 525-7 (Dec. 1, 1959).

Measurements are reported of the angular correlation between the planes of the electron pairs in the decay of the π^0 into two electron pairs by double internal conversion. Comparison of the results with theoretical predictions gives good evidence for the π^0 pseudoscalar nature, in agreement with the prediction of charge independence. E.J.Squires

539.12

2571 NEGATIVE PION INTERACTIONS AT 1.3 GeV/c. M.Blau, C.F.Carter and A.Perlmutter.
Nuovo Cimento, Vol. 14, No. 4, 704-21 (Nov. 16, 1959).

A total of 340 m of track of negative pions of momentum 1.3 GeV/c were followed in emulsion, and pion interactions recorded. Special emphasis is placed on inelastic scattering on free protons (single meson production). The resulting angular and momentum distributions of the emitted particles are investigated and compared with previous experiments at similar energies. An attempt is made to explain these results on the basis of an isobar decaying into a nucleon and the slower pion. In the case of reaction $\pi^- + p \rightarrow \pi^- + \pi^0 + p$, it appears that there exists an anisotropy in the isobar frame of reference, in which the slower pion is emitted predominantly backward, with respect to the isobar direction. The results are compared with the $\pi-\pi$ coupling model. Angular and energy distributions of mesons emitted in nuclear interactions are investigated and compared with other results and Monte Carlo calculations. The meson multiplicity and energy degradation in these collisions are also discussed. Strange particles found during the investigation are analysed.

539.12

2572 CONSEQUENCES OF A STRONG $\pi-\pi$ INTERACTION IN THE STATISTICAL THEORY OF $p-\bar{p}$ ANNIHILATION. F.Cerulus.
Nuovo Cimento, Vol. 14, No. 4, 827-35 (Nov. 16, 1959).

The Fermi statistical model for multiple particle production is applied to the $p-\bar{p}$ annihilation process; calculations are performed for three assumptions on the $\pi-\pi$ interaction, (a) a strong resonance in the state $l = 1$, $T = 1$ with total energy $4m_\pi$; (b) the same with total energy $3m_\pi$; (c) no strong interactions. Multiplicities and spectra for 2, 4 and 6-prong stars are computed. The $\pi-\pi$ isobar model (a) agrees well with experiment, taking an interaction volume $\Omega_0 = (\hbar/m_\pi c)^3 \cdot 4\pi/3$. The 2-prong spectrum shows a hump around 760 MeV kinetic energy.

539.12

2573 $\pi^+ - p$ INTERACTIONS AT 500 MeV. W.J.Willis.
Phys. Rev., Vol. 116, No. 3, 753-9 (Nov. 1, 1959).

The interaction was studied in a hydrogen bubble chamber. Phase-shift analyses with S and P waves were made, and a near degeneracy was found between the Fermi and Yang solutions. When D waves were included, an additional ambiguity was found. The D-wave phase shifts are small, but they have a considerable effect on the other phase shifts. The cross-section for single pion production is 2.85 ± 0.5 mb. The ratio $(p + 0)/(n++)$ is $1.5_{-0.3}^{+1.5}$. The cross-section leading to p++– was found to be of the order of 3 μb.

539.12

2574 PANOFSKY RATIO FOR NEGATIVE PIONS ABSORBED IN HYDROGEN. E.L.Koller and A.M.Sachs.
Phys. Rev., Vol. 116, No. 3, 760-8 (Nov. 1, 1959).

The ratio of mesonic to radiative capture of stopped negative pions in hydrogen, i.e. the Panofsky ratio,

$$P = \text{rate}(\pi^- + p \rightarrow n + \pi^0)/\text{rate}(\pi^- + p \rightarrow n + \gamma)$$

provides a useful link in analysing the results of photoproduction of pions and pion–nucleon scattering. Previous measurements of the Panofsky ratio indicate possible systematic errors in the experimental techniques. The ratio was remeasured using (a) a lead glass Cherenkov counter of improved resolution to measure the total energy of the gamma rays (±16% for the 129 MeV gamma rays measured in this experiment), (b) time-of-flight measurement of the 180° recoil neutrons to determine the shape of the pulse-height spectrum of the high-energy gamma ray, and (c) a collimator of variable dimensions to test the possible effect of degradation of the high-energy gamma rays in the collimator. The value obtained for the ratio is 1.46 ± 0.10, in good agreement with the Liverpool experiments.

539.12

2575 THE CROSS SECTION OF THE PION–NUCLEON INTERACTION AT HIGH ENERGIES. P.B.Begzhanov.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1013-14 (April, 1958) In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 699-700 (Oct., 1958).

539.12

2576 460 MeV NEGATIVE PION SCATTERING FROM NEUTRONS IN A PROPANE BUBBLE CHAMBER. J.Ballam, J.Hang, J.H.Scandrett and W.D.Walker.
Nuovo Cimento, Vol. 14, No. 1, 240-4 (Oct. 1, 1959).

A comparison is made of the angular distributions in $(\pi^- - n)$ scattering with data for $(\pi^+ - p)$ scattering obtained from a number of previous experiments at roughly the same energies. The present data are reduced to quasi-elastic scattering by neutrons by correcting for the motion of the neutrons in the carbon nucleus, and for the diffraction scattering effects. Within the assumptions made, the angular distributions for $(\pi^- - n)$ and $(\pi^+ - p)$ elastic scattering are found to be the same over the whole range of angles studied. S.J.St-Lorant

539.12

2577 THE COMPATIBILITY OF A DISPERSION RELATION FOR PION–NUCLEON SCATTERING WITH EXPERIMENTAL DATA. K.Dietz and G.Höhler.
Z. Phys., Vol. 157, No. 3, 362-8 (1959). In German.

The dispersion relation for the 3–3-amplitude given by Chew, Goldberger, Low and Nambu (Abstr. 7428 of 1957) cannot be tested at present because of the experimental uncertainties of the scattering phase, but it discriminates between several interpolations of the experimental data. The only conclusion which can be drawn from the discrepancy found by Tsuchida and Kanazawa [Progr. theor. Phys., Vol. 20, No. 3, 395-7 (Sept., 1958)] is that the Breit–Wigner formula is not suitable. It is shown here that the experimental values are consistent with the dispersion relation if an effective range formula is used up to 120 MeV. The result for the coupling constant $f^2 = 0.097$ is somewhat higher than the value used in the effective range formula, but the difference is probably not larger than the terms which are neglected in the derivation of the dispersion relation.

539.12

2578 SCATTERING OF 3.7-25 MeV POSITIVE PIONS BY HYDROGEN. G.E.Fischer and E.W.Jenkins.
Phys. Rev., Vol. 116, No.3, 749-53 (Nov. 1, 1959).

A hydrogen bubble chamber was used to investigate the π^+–p scattering cross-section in a laboratory energy range from 3.7 to 25 MeV. A total of 950 events was measured, of which 338 were caused by incident pions that would have come to rest in the chamber. Treating the small p-wave and large Coulomb contributions as known, the s-wave phase shift is found to deviate from a linear dependence on momentum only by $1\frac{1}{2}$ standard deviations.

539.12

2579 SCATTERING OF NEGATIVE MESONS BY HYDROGEN AT 130 AND 152 MeV. U.E.Kruse and R.C.Arnold.
Phys. Rev., Vol. 116, No. 4, 1008-15 (Nov. 15, 1959).

The elastic scattering and total cross-sections for π^--mesons on hydrogen were measured at 130 and 152 MeV. At both energies, the number of electrons arising from the charge exchange scattering were determined with a Cherenkov counter. At 152 MeV, recoil protons were counted, and were distinguished from π-mesons by energy loss in a scintillator. The real part of the forward scattering amplitude was determined to be 0.243 ± 0.015 and 0.218 ± 0.016, in units of the meson Compton wavelength, at 130 and 152 MeV, respectively. These values agree within limits of statistical error with the predictions from dispersion relations.

539.12

2580 ELASTIC π^+–p AND p–p SCATTERING AT 1.23 BeV/c. L.O.Roellig and D.A.Glaser.
Phys. Rev., Vol. 116, No. 4, 1001-7 (Nov. 15, 1959).

Elastic π^+–p scattering at 1.1 BeV and elastic p–p scattering at 582 MeV were measured using a propane bubble chamber. On the basis of 661 identified π^+–p elastic scatterings found in the scanning of 1.726×10^6 cm of pion track, and the total elastic cross-section is found to be 12.3 ± 1.2 mb. The differential cross-section is rather isotropic at large angles and exhibits a strong peak for small forward scattering angles. If the forward peak is interpreted as diffraction scattering according to the optical model, the data are best fitted by a proton with a π^+–p interaction radius, $R = (0.99_{-0.11}^{+0.13}) \times 10^{-13}$ cm and an opacity, $O = 0.70_{-0.07}^{+0.08}$. The total cross-section for p–p elastic scattering at 582 MeV was found to be 24.2 ± 1.6 mb, on the basis of 2442 elastic scatterings observed in the scanning of 3.000×10^6 cm of proton track. Both differential and total p–p cross-sections are in excellent agreement with the results of counter experiments in this energy region.

539.12

2581 EXPERIMENTAL EVIDENCE FOR D WAVES IN π^- – p SCATTERING AT 370 AND 427 MeV.
L.K.Goodwin, R.W.Kenney and V.Perez-Mendez.
Phys. Rev. Letters, Vol. 3, No. 11, 522-4 (Dec. 1, 1959).

The results of measurements of the π^- – p elastic differential cross-section at energies of 370 and 427 MeV are given. When the data are fitted by a power series in the cosine of the scattering angle, there is strong evidence for D waves and some indication of F waves. The probabilities that the data are consistent with S and P waves only are less than 1%. The forward cross-section is consistent with that obtained from dispersion theory. E.J.Squires

539.12

2582 DIFFRACTION SCATTERING OF FAST PARTICLES. D.I.Blokhintsev, V.S.Barashenkov and V.G.Grishin.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 311-12 (July, 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 1, 215-16 (Jan., 1959).

The inverse scattering problem is discussed for pion–nucleon scattering at 1.3 and 5 BeV π^--meson energy. The mean square "pion" radius for the nucleon is obtained as $(0.82 \pm 0.06) \times 10^{-13}$ cm at 5 BeV, in good agreement with experiment. S.J.St-Lorant

539.12 : 539.18

2583 THE π-MESONIC ATOM AND CORRECTIONS TO THE DISPERSION RELATIONS. V.A.Meshcheryakov.
Zh. eksper.teor. Fiz., Vol 35, No. 1(7), 290 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 1, 200 (Jan., 1959).

The contribution of the bound states, corresponding to the π-mesonic atom, to π^-–p scattering dispersion relations is found to be small. P.K.Kabir

539.12

2584 PHOTOPRODUCTION OF π MESONS. S.Gartenhaus and R.Blankenbecler.
Phys. Rev., Vol. 116, No. 5, 1305-11 (Dec. 1, 1959).

The dispersion relations for meson photoproduction at moderately low energies are examined by means of the comparison function method which was proposed in an earlier paper (Abstr. 2556 of 1960). Assuming that only the (3,3) state is appreciably modified by rescattering effects, an approximate solution is obtained. Nucleon recoil and crossing symmetry are treated exactly. The static limit of this solution yields substantial agreement with the results of Chew, Goldberger, Low, and Nambu (Abstr. 7438 of 1957). It is hoped that an evaluation including effects of nucleon recoil will improve the agreement in the resonance region.

539.12

2585 CALCULATION OF π^0 PHOTO-PRODUCTION FROM SCATTERING DATA. G.Höhler and A.Müllensiefen.
Z. Phys., Vol. 157, No. 1, 30-53 (1959). In German.

The cross-section for π^0-production is calculated from the results of the dispersion relation approach of Chew, Goldberger, Low and Nambu (Abstr. 7438 of 1957) and compared with the experimental data. The predictions are made using the measured values of all scattering phase shifts. A fit of the theoretical result $\sigma(90^0)$ between 260 and 370 MeV gives $f^2 = 0.082$. There is no systematic deviation from the predictions for $\sigma(90^0)$ up to $E_\gamma = 450$ MeV. The general behaviour of the asymmetry coefficient B is correct. A quantitative comparison which would show the contribution of the unknown electric dipole term $N^{(+)}$ of Chew et al. is only reasonable after the calculation of B and the measurements have been improved. C/A depends strongly on the small phases up to 240 MeV. The effects of the small phases are pretty large for $\sigma(150^0)$ but there is no discrepancy similar to the results for π^+-production above 290 MeV. The formula for the cross-section does not reduce to the results of the phenomenological theories of Brueckner–Watson, Sachs et al. and Feld, if the simplifications made by these authors are taken into account. The origin of the differences is discussed.

539.12

2586 MESON PRODUCTION BY 280 MeV π^+-MESONS ON PHOTOEMULSION NUCLEI.
Yu.A.Batusov, N.P.Bogachev, V.M.Sidorov and I.Chulli.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 491-4 (Sept. 21, 1959).
In Russian.

NIKFI-R emulsions, 400 μ thick, were scanned and 3000 stars produced by 280 MeV π^+-mesons were found. Approximately 0.5% of these have two charged secondary mesons, and 40% only one such meson. The data obtained are used to estimate the cross-section for the process $\pi^+ + n \rightarrow \pi^+ + \pi^- + p$. The value obtained is (0.3 ± 0.2) millibarns. S.Chomet

539.12

2587 CONSIDERATIONS ON THE CROSS SECTION FOR PION PRODUCTION IN PROTON–PROTON COLLISIONS. E Ferrari.
Nuovo Cimento, Vol. 13, No. 6, 1285-9 (Sept. 16, 1959).

Proposes an application of the Chew–Low extrapolation method (Abstr. 7241 of 1959). Since the result of extrapolation is known in advance in this case, a test of the method is provided. R.J.N.Phillips

539.12

2588 STATISTICAL INTERPRETATION OF EXPERIMENTAL DATA ON MULTIPLE PRODUCTION OF PARTICLES AT ENERGIES OF 1-20 BeV. V.M.Maksimenko.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1302-4 (Nov., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 909-10 (May, 1959).

A comparison of experimental data on multiple pion production in nucleon–nucleon and pion–nucleon collisions with Fermi's statistical theory. Good agreement is obtained for the pion multiplicities and momentum distributions if isobaric states are considered. C.J.Batty

539.12

2589 SEARCH FOR NEW NEUTRAL MESONS (THE ρ^0-MESONS). C.Bernardini, R.Querzoli, G.Salvini, A.Silverman and G.Stoppini.
Nuovo Cimento, Vol. 14, No. 1, 268-71 (Oct. 1, 1959).

A search was made for the step in the excitation curve for the

photoproduction of protons of a given energy at a given angle along with a ρ^0-meson. The curve fitted well with the π^0 photoproduction and gave no appreciable sign of a heavier meson. From an order of magnitude estimate of two pion photoproduction an upper limit of 1.5×10^{-31} cm^2 was placed on the differential cross-section for the production of 105 MeV protons at 42°, along with a ρ^0-meson.

A.Ashmore

539.12

2590 FORM FACTORS IN $K_{\mu 3}$ AND K_{e3} DECAY. S.W.MacDowell.

Phys. Rev., Vol. 116, No. 4, 1047-9 (Nov. 15, 1959).

An investigation of the form factors in $K_{\mu 3}$ and K_{e3} decay amplitudes, on the assumption of local production of the fermion pair, is carried out by means of dispersion relation techniques. The approximation is made of taking explicit account of K–π scattering in the unitarity condition and incorporating all the other contributions into a single arbitrary parameter. The validity of this approximation is discussed. The results are expressed in terms of S and P phase shifts for K–π scattering.

539.12

2591 INTERACTIONS OF 1.15 GeV/c K^- MESONS IN EMULSIONS. PRELIMINARY RESULTS. C.M.Garelli, B.Quassiati, L.Tallone and M.Vigone.

Nuovo Cimento, Vol. 13, No. 6, 1294-5 (Sept. 16, 1959).

400 stars have been found in a stack of emulsions exposed to a separated K^- beam. It is estimated that at least 50 of these are due to π^- contamination. The prongs which could be followed to rest yielded, as well as 2223 stable prongs, $22\pi^-$, $8\pi^+$, $6K^-$ re-emitted, 5 hyperfragments and 40 charged Σ hyperons. An estimate of the loss factor for Σ hyperons increases the last figure to ~70. A careful search for double hyperon production has produced one possible case of the process $K^- + n + p \rightarrow \Sigma^+ + \Sigma^- + K^0$. S.J.Goldsack

539.12

2592 NOTE ON THE K^-–DEUTERON COLLISION. S.Minami.

Nuovo Cimento, Vol. 14, No. 4, 767-70 (Nov. 16, 1959).

The process of $K^- + d \rightarrow \mathcal{N} + \mathcal{N} \bar{K}$ is investigated from the kinematical point of view under the assumption that there exists an excited state Σ^* for the K^-–$\mathcal{N}$ system. It is pointed out that the reaction $K^- + d \rightarrow n + n + K^0$ in the low energy region turns out to be forbidden owing to the Pauli principle in addition to the conservation laws of the total angular momentum and parity. Moreover the parity of Σ^* is discussed on the basis of the character for angular distribution of $\bar{K}$-meson.

539.12

2593 K^+–NUCLEON SCATTERING IN THE TAMM–DANCOFF APPROXIMATION. G.Białkowski and A.Jurewicz.

Phys. Rev., Vol. 116, No. 5, 1269-71 (Dec. 1, 1959).

Calculations of K^+–nucleon scattering phase shifts are reported. A simple model of Yukawa interactions between K-mesons and baryons (containing no derivatives) is adopted. The method used is a three-dimensional Tamm–Dancoff approximation but with no simplifications as far as recoil effects are concerned. This method is particularly convenient for K^+–nucleon scattering, since the principle of associated production excludes graphs leading to non-renormalizable effects. The resulting integral equation has been solved for the $T = 1$, $S_{\frac{1}{2}}$, $P_{\frac{1}{2}}$, and $P_{\frac{3}{2}}$ states in the energy region up to 1.26 BeV. The coupling constant is the only parameter to be determined from experimental data. This was chosen to fit the experimental value of the total cross-section at about 350 MeV. It was found that the best agreement with experiment was obtained with $(G^2 + \mathcal{G}^2)/4\pi = 12.5$. This value is much greater than the corresponding one adopted in previous papers.

539.12

2594 THE STATISTICAL WEIGHTS OF K^+- and K^-- MESONS PRODUCED IN PION–NUCLEON COLLISIONS. É.K.Mikhul.

Zh. eksper. teor. Fiz., Vol.35, No.1(7), 298-9 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol.35(8), No.1, 205-6 (Jan., 1959).

Probabilities for production of K^+- and K^--mesons in 5 BeV pion–nucleon collisions are calculated on the basis of Gell-Mann's global symmetry and the Goldhaber–Christy model.

S.J.St-Lorant

Hyperons

539.12

2595 THE INELASTIC SCATTERING OF Σ^+ HYPERONS WITH EMULSION NUCLEI. D.H.Davis, B.D.Jones and J.Zakrzewski.

Nuovo Cimento, Vol. 14, No. 1, 265-7 (Oct. 1, 1959).

Describes the dynamics of two events found in nuclear emulsion, which can be interpreted as the inelastic scattering of Σ^+ hyperons according to the reactions

$$\Sigma^+ + \begin{pmatrix} p \\ n \end{pmatrix} \rightarrow \Sigma^+ + \begin{pmatrix} p \\ n \end{pmatrix}$$

S.J.St-Lorant

539.12

2596 METHOD FOR DETERMINING HYPERON POLARIZATION IN THE REACTION $\pi + p \rightarrow Y + K$. S.M.Bilen'kii and R.M.Ryndin.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 827-8 (Sept., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 3, 574-5 (March, 1959).

It is suggested that measurement of the azimuthal asymmetry of hyperons in the above reaction, using a polarized proton target, or in a similar reaction $K + p \rightarrow Y + \pi$, would provide information on hyperon polarization. The sign of the asymmetry factor is related to the K–Y relative parity and could be used to determine the latter, provided the sign of the hyperon polarization is known. P.K.Kabir

539.12

2597 EMISSION OF Λ^0-PARTICLES UPON CAPTURE OF K-MESONS BY NUCLEI IN EMULSION. S.A.Bunyatov, A.Vrublevskii, D.K.Kopylova, Yu.B.Korolevich, N.I.Petukhova, V.M.Sidorov, E.Skzhipchak and A.Filipkovskii.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1028-30 (April, 1958). In Russian. English translation in : Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 711-12 (Oct., 1958).

Ilford G5 emulsion was exposed to K^--mesons of momentum 300 MeV/c. 18 Λ^0-decays were found and parent events could be assigned to 13 of them. E.J.Burge

Strange particles

539.12

2598 METHOD FOR DETERMINATION OF STRANGE PARTICLE PARITIES AND COUPLING CONSTANTS. J.G.Taylor.

Phys. Rev., Vol. 116, No. 3, 768-73 (Nov. 1, 1959).

A general method for determining parities and coupling constants of strange particles directly from angular distributions is described. A reasonably detailed discussion is given of what can be gleaned by this method from the processes of associated production by photons on nucleons and by pions on protons, and from the absorption and charge exchange scattering of charged K mesons on nucleons. If the relative parity of K^+ to K^0 is odd then strange-particle parities may be obtained from all these processes, while if this relative parity is even only photoproduction processes may be used to determine parities Once these relative parities have been determined then coupling constants may be obtained from all the processes

539.12

2599 ON A METHOD FOR DETERMINING THE PARITY OF STRANGE PARTICLES. É.I.Dolinskii.

Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1293-4 (Nov., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 902-3 (May, 1959).

The absorption of K^--mesons (from s-states) by polarized protons leads to the production of polarized hyperons in the reaction $K^- + p \rightarrow Y + \pi$. The degree of polarization of the hyperon depends on the parity of the K–hyperon system relative to the proton, and the sign is opposite in the two cases. The hyperon decay can be used as an analyser of the polarization, therefore this affords a method for determining the intrinsic parity of the strange particles. Similar results hold for the absorption in polarized nuclei. P.K.Kabir

Deuterons

539.12

2600 **SCATTERING OF DEUTERONS BY DEUTERIUM AND TRITIUM AT LOW ENERGIES.**
Yu.G.Balashko and I.Ya.Barit.
Zh. eksper. teor. Fiz., Vol.34, No.4, 1034-6 (April, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol.34(7), No.4, 715-16 (Oct., 1958).

Measurements are reported of D–T scattering at 90° from 30 to 300 keV (c.m.) and are compared with values computed on a basis of resonance and potential scattering. D–D scattering at 67° was measured from 100-600 keV (c.m.) E.J.Burge

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

537.59

2601 **PROBLEMS IN THE INTERPRETATION OF COSMIC RAY NUCLEAR INTERACTIONS. K.Sitte.**
Czech. J. Phys., Vol. 9, No. 3, 271-87 (1959).

Difficulties in the interpretation of high-energy nuclear interactions are discussed and explanations suggested on the basis of successive or composite nucleon–nucleus collisions, the first predominant below a few 10^{11} eV, the second at higher energies. In the energy region up to about 10^{11} eV, some discrepancies in the frequency of production of strange particles, the small interaction cross-section of iron, etc., are explained, taking into account secondary intranuclear collisions. The "tunnel" model of Heitler and McCusker is replaced by assuming a cone-shaped interaction volume ("funnel") even at the highest primary energies. A number of consequences concerning the energies of the primary particles (the multiplicity and asymmetry in the angular distribution of secondaries, coefficient of inelasticity, etc.) are discussed.

537.59

2602 **OBSERVATION OF NUCLEAR-ACTIVE PARTICLES OF COSMIC RADIATION WITH ENERGY $\geq 10^{13}$ eV.**
E.A.Murzina, S.I.Nikol'skii and V.I.Yakovlev.
Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1298-300 (Nov., 1958), English translation in : Soviet Physics–JETP (New York), Vol.35(8), No.5, 906-7 (May, 1959).

The flux intensity of high-energy nuclear-active particles of cosmic radiation was measured at 3860 m above sea level. The detector consisted of seven ionization chambers surrounded by lead. The experimental data showed that nuclear-active particles with energy $\geq 2 \times 10^{13}$ eV are accompanied in 81 ± 3% of the cases by extensive air showers with the number of particles greater than 3×10^5. Nuclear-active particles of $\geq 1.5 \times 10^{13}$ eV energy are accompanied by such showers in 83 ± 4% of the cases This shows that the particles are accompanied by extensive air showers almost independently of their energy. In the energy region 10^{13} to 10^{15} eV the energy spectrum is given by the formula

$$F(>E) \sim 1/E^{1.33 \pm 0.07}$$

which is in agreement with the energy spectrum of the primary cosmic radiation in this energy region. The results also suggest that primaries of energies $> 3 \times 10^{14}$ eV lose their energy on the production of secondaries in the first interaction and are absorbed in the atmosphere sooner than lower-energy particles.
C.F.Barnaby

537.59

2603 **FURTHER INVESTIGATION OF A HIGH ENERGY JET.**
G.Bozoki, G.Domokos, E.Fenyves, A.Frenkel, E.Gombosi, D.Bebel, K.Lanius and H.W.Meier.
Nuovo Cimento, Vol.13, No.3, No.3, 662-4 (Aug. 1, 1959).

Additional measurements have been made on a $0 + 16\alpha$ jet event. By means of relative and multiple scattering, lower limits have been obtained for the energies of the shower particles. The soft cascades have been analysed using Pinkau's method in order to obtain an estimate of the energy of the π^0 component. The primary energy has been computed according to several different methods. A minimum value of 0.1 is deduced for the inelasticity of the interaction.
E.G.Michaelis

537.59

2604 **NUMERICAL CALCULATIONS ON THE NEW APPROACH TO THE CASCADE THEORY. I.**
S.K.Srinivasan and N.R.Ranganathan.
Proc. Indian Acad. Sci. A, Vol. 45, No. 2, 69-73 (Feb., 1957).

Calculations were made on the basis of the theory given in Abstr. 6317 of 1957.

537.59

2605 **A NOTE ON CASCADE THEORY WITH IONISATION LOSS. A.Ramakrishnan and S.K.Srinivasan.**
Proc. Indian Acad. Sci. A, Vol. 45, No. 2, 133-8 (Feb., 1957).

The cascade theory of cosmic-ray showers, including ionization loss, is dealt with on the basis of the approach given in an earlier paper (Abstr. 6317 of 1957) and an explicit Mellin transform solution is obtained for the mean number of particles produced in an infinite thickness of matter.

537.59

2606 **MULTIPLE PROCESSES IN ELECTRON-PHOTON CASCADES. A.Ramakrishnan, S.K.Srinivasan, N.R.Ranganathan and R.Vasudevan.**
Proc. Indian Acad. Sci. A, Vol. 45, No. 5, 311-26 (May, 1957).

Recent experiments on high energy electron-photon cascades suggest the possibility of the following multiple processes: (i) Electron scattering with pair creation, (ii) Electron scattering with the emission of two photons, and (iii) Photon scattering with pair creation. The cross-section for the first process predicted by Bhabha has been recalculated recently by the standard Feynman technique. Using the same technique, calculations are presented for the cross-sections of processes (ii) and (iii).

537.59

2607 **AN ESTIMATE OF THE ENERGY OF SHOWER-PRODUCING PARTICLES WITH ALLOWANCE FOR THEIR ENERGY SPECTRUM. Zh.S.Takibaev.**
Zh. eksper. teor. Fiz., Vol.35, No.1(7), 277-9 (July, 1958).
In Russian. English translation: Soviet Physics–JETP (New York), Vol.35(8) No.1, 191-2 (Jan., 1959).

It is shown how one can take into account the energy spectrum of shower-producing particles in estimating their energies from the angular distribution of the secondary particles. E.J.Squires

537.59

2608 **ON THE GEOMAGNETIC EFFECT IN EXTENSIVE AIR SHOWERS. Y.Oren.**
Bull. Res. Coun. Israel, Vol. 8F, No. 2, 103-12 (Dec., 1959).

In view of the discrepancies between the experimental results on the geomagnetic effect in E.A.S. and theoretical calculations based on electromagnetic cascade theory, alternative possibilities were investigated. Of the various components, only the contribution of muons is appreciable, because of their large production height (above 5 km) and relatively long lifetime. The relatively flat lateral distribution of the muons and their appreciable ellipticity could explain the fact that the observed ellipticity seems to increase with the distance of the detectors from the core. An experiment was carried out in which the ratios of particle densities at 7 and 14 metres from the shower core and the ratio of muon densities at 14 m distance were measured. The data, must however, be corrected for the uncertainty of the core location, which reduces the differences in densities detected. The measured ellipticities — in all cases about 10% — are well in excess of the value predicted by calculations based on electromagnetic cascade theory.

537.59

2609 **THE COSMIC RAY STORM OF MAY 11, 1959.**
F.Bachelet, P.Balata, A.M.Conforto, N.Iucci and G.Marini.
Nuovo Cimento, Vol.13, No.5, 1055-9 (Sept. 1, 1959).

A sudden decrease is reported in the nucleonic component (9%), total ionizing (5.7%) and meson components (5.7%), measured in Rome on May 11th, 1959, and is related to variations in the geomagnetic field, geomagnetic storms and solar activity. E.J.Burge

537.59

2610 **HIGH ALTITUDE NEUTRON INTENSITY DIURNAL VARIATION. R.C.Haymes.**
Phys. Rev., Vol. 116, No. 5, 1231-7 (Dec. 1, 1959).

Two balloon flights in which boron trifluoride neutron counters were carried aloft were launched from Brownwood, Texas, during

September, 1958. The flights attained altitudes of 86 000 and 79 000 ft at a conventional geomagnetic latitude of 41°N. They showed that the slow-neutron intensities in the atmosphere had decreased by about 12% since the time of minimum solar activity in 1954. They also show that this decrease was mainly in the low-energy end of the spectrum, as the mean free path for absorption had increased from 180 ± 25 g/cm² to 240 ± 30 g/cm². A high-altitude decrease apparently associated with the geomagnetic storm of 25th Sept., 1958 was also detected. After achieving altitude, the balloons floated at a constant elevation through sunset. A sharp peak in the intensity which occurs just before sunset at balloon altitudes was detected on both flights. The origin of this phenomenon, which results in a doubling of the intensity for about 25 min, is unexplained, although some possible mechanisms are discussed.

537.59

2611 A STUDY OF FAST DEUTERONS AT 3200 M ABOVE SEA LEVEL.

G.V.Badalyan.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 303-5 (July, 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 1, 209-10 (Jan., 1959).

The study was carried out at Mount Aragats, by means of a magnetic spectrometer associated with two multiplate cloud chambers (Abstr. 3411 of 1957). The deuterons were identified by momentum measurements as well as by ionization range in the lower cloud chamber. 242 deuterons with range between 1.2 and 5.4 cm Pb were registered in the lower chamber, and of these 81 entered the chamber from the air. This number amounts to 0.063± 0.0072 of the corresponding number of protons registered in the same time. This value is in good agreement with other data [Aivazyan, Izvestiya Akademii nauk Armyanskoi SSR, Ser. fiziko-matematicheskikh nauk, Vol. 9, 91(1956)]. The results are given in the form of histograms; the momentum spectrum of the deuterons is deduced in analytical form. The results are in good agreement with the idea of a direct or indirect pick-up mechanism for the production of fast deuterons. G.Martelli

537.59

2612 SEA-LEVEL COSMIC-RAY MASS SPECTRUM IN THE INTERVAL $30m_e$–$2000m_e$.

G.G.Fazio and M.Widgoff.
Phys. Rev., Vol. 116, No. 5, 1263-6 (Dec. 1, 1959).

In nuclear emulsion stacks exposed to sea-level cosmic radiation under 180 g cm^{-2} of iron, no evidence for mass values in the regions 30 to $100m_e$ and 400 to $900m_e$ was found. If such particles do exist, their intensity relative to that of μ-mesons stopping in the same range interval must be as follows: for 30 to $100m_e$, ≤0.13%; for 400 to $900m_e$, ≤0.04%.

537.59

2613 SEARCH FOR ANOMALOUS LIFETIME VALUES IN SEA-LEVEL COSMIC RADIATION.

G.G.Fazio and D.M.Ritson.
Phys. Rev., Vol. 116, No. 5, 1267-9 (Dec. 1, 1959).

By use of a scintillation counter telescope, sea-level cosmic-radiation was investigated for the existence of particles of mass greater than $60m_e$, decaying with lifetimes in the millisecond region. If such particles exist, their intensity, relative to μ-mesons, for various lifetime ranges, must be as follows: for 10^{-4} to 10^{-2} sec, ≤0.03%; for 10^{-4} to 5×10^{-3} sec, ≤0.1%; for 10^{-4} to 10^{-1} sec, ≤0.14%; for 10^{-4} to 10^{-1} sec (for decay into a light meson), ≤0.03%; for 10^{-4} to 1.0 sec, ≤1.4%.

537.59 : 551.5

PRODUCTION OF RADIOISOTOPES IN THE ATMOSPHERE BY COSMIC RADIATION. See Abstr. 2041

NUCLEUS

539.14

2614 THE STRUCTURE OF THE ATOMIC NUCLEUS.

R.J.Blin-Stoyle.
Contemporary Physics, Vol. 1, No. 1, 17-34 (Oct., 1959).

The properties of the atomic nucleus are summarized and shown to be consistent with a description in which the nucleus is regarded as an assembly of elementary particles (neutrons and protons) bound together by means of nuclear forces. Because of the formidable difficulty of giving a full theoretical treatment of this many-body problem, nuclear models are introduced which can account in a semi-quantitative fashion for many of the nuclear properties. Finally, a discussion is given of the way in which these models are related to one another and to a "true" description of the nucleus.

539.14

2615 IMAGINARY PART OF THE OPTICAL POTENTIAL.

L.C.Gomes.
Phys. Rev., Vol. 116, No. 5, 1226-9 (Dec. 1, 1959).

The imaginary part of the optical potential was investigated for low-energy incoming neutrons, by means of the nucleon–nucleon cross-sections in nuclear matter. The cross-sections were calculated under the assumption that pair correlations for low excited states of nuclear matter are the same as those formed in the ground state. The dependence of the effective mass on the single-particle momentum was taken into consideration using an empirical solution which reproduces the present assumptions for the single-particle spectrum. The results have been applied to the nuclear surface in the Thomas–Fermi approximation. The maximum in the imaginary potential was found to be at the surface outside of the half-density radius. For low incident energies it is about 1.5×10^{-13} cm beyond this radius.

539.14

2616 NUCLEONIC INTERACTION WHICH PRODUCES A SUPERFLUID STATE OF THE NUCLEUS. V.G.Solov'ev.

Zh. eksper. teor. Fiz., Vol.35, No.3(9), 823-5 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol.35(8), No.3, 572-3 (March, 1959).

The methods used in the Bogolyubov theory of superfluidity are applied to finite nuclei. It is assumed that there is an attractive interaction between nucleons in the same shell which have equal and opposite values of the projection of their angular momenta on the symmetry axis. By making the Bogolyubov transformation and using the variational principle it is shown that the lowest state separates off from the excited states by an amount ΔE, which is analogous to the energy gap in the model of a superfluid. E.J.Squires

539.14

2617 COLLECTIVE ENHANCEMENT OF E2 MATRIX ELEMENTS IN LIGHT NUCLEI.

S.Fallieros and R.A.Ferrell.
Phys. Rev., Vol. 116, No. 3, 660-73 (Nov. 1, 1959).

Several electric quadrupole transitions in nuclei in the neighbourhood of O^{16} are discussed. The well-known strong enhancement of the single-nucleon matrix elements is interpreted as resulting from the virtual excitation of a collective 2+ state in the O^{16} core. It is found that an energy of 18 MeV for this state gives a satisfactory account of all of the experimental data. The enhanced matrix elements are expressed in terms of an effective charge, which is calculated in detail within the framework of the nuclear shell model. The value of the effective charge depends on the particular independent-nucleon states involved in the transition and is found to be approximately 0.5, 0.7, and 0.9 for 2s-1d, 1d-1d, and 1p-1p matrix elements, respectively. Of special interest is the result that the N^{14} quadrupole moment should possess the relatively large value of 3×10^{-26} cm², or about three times the simple shell-model value. This prediction has recently been confirmed by high-energy electron scattering measurements. The relation of the present work to previous theoretical treatments of enhancement by the methods of the hydrodynamic model and of configuration mixing is discussed. An appendix on centre-of-mass effects contains an explicit demonstration of the cancelling of the classical recoil quadrupole moment of O^{17} by a quantum mechanical exchange term.

539.14

2618 THE EFFECT OF CONFIGURATION MIXING IN THE SHELL MODEL STUDY OF C^{14}, N^{14} AND O^{14} NUCLEI.

K.Ott.
Z. Naturforsch., Vol. 14a, No. 9, 769-83 (Sept., 1959). In German.

The effect of d-admixture in the shell model wave-function of the A = 14 multiplet is investigated in an attempt to explain the long lifetime of C^{14} in β-decay and the sign and magnitude of the quadrupole moment of the N^{14} nucleus. A fit is obtained for two very different types of exchange interaction: (1) strong central forces with weak long-range tensor forces; (2) weak central forces

with strong short-range tensor terms. In the latter case, deviations of p-shell results from empirical data are of the same order of magnitude as the computed contribution from the configuration mixture so that any improved agreement with the higher order terms neglected may be regarded as coincidental. S.J.St-Lorant

539.14

2619 ON THE THEORY OF THE "SECOND MOMENT" IN THE NUCLEAR MODEL OF LANE, THOMAS AND WIGNER. V.M.Agranovich and V.S.Stavinskii.
Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1285-7 (Nov., 1958).
In Russian. English translation in: Soviet Physics –JETP (New York), Vol.35(8), No.5, 896-8 (May, 1959).

The second moment of the C-coefficients in this model (Abstr. 6392 of 1955), related to the widths of giant resonances, is discussed. Introducing a thermal weighting, a formula is derived for this second moment in terms of nuclear excitation energy and mass number. R.J.N.Phillips

539.14

2620 MEASUREMENT OF THE SPIN AND PARITY OF THE ANOMALOUS INELASTIC STATES IN Ni^{58} AND Ni^{60}. M.Crut and N.S.Wall.
Phys. Rev. Letters, Vol. 3, No. 11, 520-2 (Dec. 1, 1959).

Curves for the differential cross-section of alpha particles scattered elastically and inelastically to the first excited state and the anomalous peak at about 4.5 MeV, by Ni^{58} and Ni^{60}, are given. The energy distribution and angular correlation of the gamma-ray, corresponding to the decay from the anomalous state, are also given. From the angular distribution the parity of the anomalous state is found to be negative, and from the correlation of the gamma decay to the first excited state its spin is found to be 3^-. E.J.Squires

539.14

2621 Cd^{111}–Cd^{113} NUCLEAR MOMENT RATIO AND HYPERFINE ANOMALY. M.P.Klein and J.S.Waugh.
Phys. Rev., Vol. 116, No. 4, 960-1 (Nov. 15, 1959).

A double-resonance method was employed to measure the nuclear moment ratio Cd^{111}:Cd^{113}. The result is $\mu_{113}/\mu_{111} = 1.046083 \pm 0.000003$. This value is compared with recently reported hyperfine coupling intervals. A similar experiment on Hg^{199} and Hg^{201} was not successful.

539.14 : 539.17

DIPOLE STATE IN NUCLEI. See Abstr. 1429

539.14

2622 COULOMB EXCITATION OF ALUMINIUM. D.G.Alkhazov, A.P.Grinberg, G.M.Gusinskii, K.I.Erokhina and I.Kh.Lemberg.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1055-6 (Oct., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 736-7 (April, 1959).

A study of the γ-radiation emitted when Al^{27} was bombarded by 15.9 MeV N^{3+} and 18.1 MeV O^{3+} ions. Two lines were observed at 0.84 and 1.01 MeV. The transitions are electric quadrupole ones. The (partial) lifetimes of the corresponding levels were estimated as 3.7×10^{-11} and 1.7×10^{-11} sec. L.Pincherle

539.14

2623 FLUCTUATIONS IN PARTIAL RADIATION WIDTHS. L.M.Bollinger, R.E.Coté and T.J.Kennett.
Phys. Rev. Letters, Vol.3, No.8, 376-8 (Oct. 15, 1959).

Partial widths for individual radiative transitions resulting from the resonant capture of slow neutrons in Hg^{199}, Pt^{195} and W^{183}, have been measured using improved experimental techniques. The object of the work was to resolve discrepancies between various sets of results which had disagreed about the amount of fluctuation among the partial widths. The high energy ends of the resonant capture gamma ray spectra were studied in sufficient detail to determine the probabilities of transitions not only to the ground state but also to one or more of the low energy states of the compound nucleus. A single large (4×4 in.) NaI(Tl) crystal was used to measure the spectra. The authors find wide fluctuations in the partial widths for a given nuclide but a surprising degree of uniformity from nuclide to nuclide. They ascribe previous discrepancies to failure to resolve neighbouring transitions. J.D.Dowell

539.14 : 539.17

2624 NUCLEAR ENERGY LEVELS IN C^{13}, N^{13}, N^{14}, N^{15}, O^{15}, AND F^{19} FROM He^3 INDUCED REACTIONS. T.E.Young, G.C.Phillips, R.R.Spencer, and D.A.S.N.Rao.
Phys. Rev., Vol. 116, No. 4, 962-9 (Nov. 15, 1959).

A 5.5-MeV Van de Graaff accelerator and a magnetic spectrograph were used to study reaction products produced by He^3 bombardment of B^{11}, C^{12}, C^{13}, N^{14}, and O^{16}. Q values of 9.5, 9.3, 6.31, 5.68, 5.63, 5.49, 4.31, 3.67, and 3.29 MeV were observed for the $B^{11}(He^3,p)C^{13}$ reaction, corresponding to excitations of from 3.7 to 9.90 MeV in C^{13}. The energy levels at 7.69 and 8.87 MeV in C^{13}, for which the Q values were 5.49 and 4.31 MeV, were determined to have widths of approximately 75 and 175 keV, respectively. For the $C^{13}(He^3,p)N^{15}$ reaction the observed Q values were 5.38, 4.33, 3.50, 3.36, 3.09, 2.35, 2.09, 1.61 and 1.50 MeV. The $O^{16}(He^3,p)F^{18}$ reaction revealed the existence of twelve states below 3.9 MeV of excitation in F^{18}. These states occur at 0.943, 1.047, 1.089, 1.128, 1.708, 2.102, 2.521, 3.058, 3.130, 3.355, 3.724, and 3.843 MeV of excitation. The ground-state Q values of the $O^{16}(He^3\alpha)O^{15}$ and $N^{14}(He^3,d)O^{15}$ reactions were determined to be 4.91 and 1.80 MeV, respectively, and the first excited state of O^{15} was observed at 5.17 MeV by means of the $O^{16}(He^3,p)O^{15}$ reaction.

539.14

2625 A SEARCH FOR (Σ^+p) HYPERNUCLEI. R.C.Kumar and F.R.Stannard.
Nuovo Cimento, Vol. 14, No. 1, 250-2 (Oct. 1, 1959).

1200 K^- capture stars, used previously for the European K^-stack collaboration (Abstr. 13575 of 1959), were re-examined for (Σ^+p) hypernuclei. Decay into $d + \pi^+$ or $p + p$ would readily be identified but none were found. Analysis of particles coming to rest to produce two heavy prongs revealed only two with the Q value for decay into $p + \pi^0 + p$. One of these was eliminated by integrated gap measurements and the other could not certainly be identified as a (Σ^+p) decay. Of 9 tracks ending in a heavy and a light prong, as for decay into $n + \pi^+ + p$, 7 were found to have π^- mesons. The other two could not be followed to the end. A.Ashmore

539.14

2626 HYPERFRAGMENTS FROM σ_K STARS. B.P.Bannik and S.A.Buniatov.
Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1307-8 (Nov., 1958).
In Russian. English translation in Soviet Physics–JETP (New York), Vol.35(8), 913-14 (May, 1959).

Four cases are reported, and three identified, of mesonic decay of hyperfragments from 619 σ_K stars, and two nonmesonic decays among 427 σ_K stars, observed in nuclear emulsions irradiated with K^- mesons. E.J.Burge

539.14

2627 HYPERFRAGMENTS AND ISOTOPIC SPIN SELECTION RULES. M.S.Swami and B.M.Udgaonkar.
Nuovo Cimento, Vol. 14, No. 4, 836-48 (Nov. 16, 1959).

The branching ratios in the decays of hyperfragments are examined in the light of the selection rule $\Delta T = \frac{1}{2}$, the hyperfragments considered being the doublets $({}_\Lambda H^4, {}_\Lambda He^4)$, $({}_\Lambda He^6, {}_\Lambda Li^6)$, $({}_\Lambda Li^8, {}_\Lambda Be^8)$ and the hypernucleus ${}_\Lambda Li^7$. The experimental information on the doublet $({}_\Lambda H^4, {}_\Lambda He^4)$ is discussed in relation to this selection rules. It is pointed out that a systematic collection of much more data than are available at present is necessary in order to test the validity of the $\Delta T = \frac{1}{2}$ rule in this domain.

539.14

2628 THE MESON DECAY OF LIGHT HYPERFRAGMENTS. Z.Korbel and L.Rob.
Czech. J. Phys., Vol. 9, No. 3, 288-90 (1959). In Russian.

The binding energies of five types of light hyperfragment, i.e. of atomic nuclei of light elements containing one hyperon instead of one neutron, were measured. The hyperfragments were originated by means of the interaction of K^- mesons with the nuclei of light elements, contained in an emulsion.

539.14

2629 PIONIC DECAY MODES OF LIGHT Λ HYPERNUCLEI. R.H.Dalitz and L.Liu.
Phys. Rev., Vol. 116, No. 5, 1312-21 (Dec. 1, 1959).

Decay probabilities are calculated for pionic modes of decay of the Λ hypernuclei $A \leq 5$. An effect of the Pauli principle omitted in previous calculations (Abstr. 2657 of 1959) for the two-body π^- and π^0 modes is now included. An estimate for the total decay prob-

ability of all π^- (or π^0) modes based on the completeness relation is checked by comparison with calculations based on detailed models of the decay process for two particular systems. As a result, the present data on $_{\Lambda}H^4$ decay are now consistent with either (a) spin $J = 0$ for any value p/s less than 1.5, or (b) spin $J = 1$ for any value p/s greater than 1.2, a much weaker conclusion than that reached previously. In either case, if the $\Delta T = \frac{1}{2}$ rule is roughly correct for Λ decay, the two-body mode $\pi^0 + \alpha$ will be prominent among $_{\Lambda}He^4$ decay modes. The π^0/π^- ratio will then be large (~ 1.5) for $_{\Lambda}He^4$ decay and small (~ $\frac{1}{4}$) for $_{\Lambda}H^4$ decay, compared with the value ~ $\frac{1}{2}$ for $_{\Lambda}He^5$ and $_{\Lambda}H^3$ decay.

RADIOACTIVITY

539.16 : 551.5

2630 ON THE DISTRIBUTION OF ACTIVITY IN RADIOACTIVE RESIDUES FROM ATMOSPHERIC PRECIPITATES. V.Mageru, D.Blănariu and I.Gabe.
Naturwissenschaften, Vol. 46, No. 19, 553 (1959). In German.

A brief note discussing and comparing in general terms certain methods for measuring the radioactivity in atmospheric precipitates.
J.D.Craggs

539.16

2631 AN ELECTRO-FILTER FOR THE REMOVAL OF RADIOACTIVE AEROSOLS. W.Riezler and W.Kern.
Nucleonik, Vol. 1, No. 5, 191-5 (April, 1959). In German.

Air is drawn through the filter of 80 × 80 cm cross-section at the rate of 1700 m^3/hr. Particles are charged in a field of 4 kV/cm and extracted by passing the air between a series of charged parallel plates (8 kV/cm). The extraction rate is 70 to 90%. The theory of charged particle removal is discussed and comparison with traditional filters is made.
J.R.Mallard

539.16

2632 A STUDY OF METHODS FOR OBTAINING HIGH RESOLUTION WITH A PAIR SPECTROMETER.
G.A.Bartholomew, P.J.Campion and K.Robinson.
Canad. J. Phys., Vol. 38, No. 2, 194-216 (Feb., 1960).

Methods of improving the resolution and line shape of a flat magnetic field pair spectrometer with the aid of specially designed detector apertures are described. The performance of two such apertures is described in detail. The theoretical line shape and resolution for one type of aperture are calculated and compared with experiment.

539.16

2633 ALPHA-DECAY OF ISOMERIC Bi^{210}.
S.V.Golenetskii, L.I.Rusinov and Yu.I.Filimonov.
Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1313-15 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol.35(8), No.5, 917-18 (May, 1959).

The alpha spectrum from the decay of the long-lived isomer of Bi^{210} was studied using a pulse ionization chamber and an enriched, purified sample of Bi^{210}. In addition to the previously observed alpha-particles with energy 4935 ± 10 keV, two new groups were found with energies of 4900 ± 10 and 4640 ± 30 keV, the relative intensities of the three lines being 60, 30 and 10% respectively. Gamma-rays of energy 260 and 300 keV were observed in coincidence with the alphas, corresponding to de-excitation transitions of the Tl^{206} residual nucleus, for which levels are proposed at 40 and 300 keV above the ground state.
A.E.I.Research Laboratory

539.16

2634 DEMONSTRATION OF A FERMI COMPONENT IN THE β-DECAY OF A^{41} BY MEANS OF POLARIZATION CORRELATION MEASUREMENTS.
T.Mayer-Kuckuk, R.Nierhaus and U.Schmidt-Rohr.
Z. Phys., Vol. 157, No. 5, 586-91 (1960). In German.

The correlation between β-particles and circular polarized γ-radiation was measured for the $J \rightarrow J$ β^--transition A^{41}—K^{41}. Gaseous sources were used. A correlation coefficient $A = (+0.33 \pm 0.07)$ was found. from this, a ratio of Gamow–Teller to Fermi matrix element $M_G/M_F = +2.3^{+0.9}_{-1.3}$ and a Fermi matrix element $M_F = 0.09 \pm 0.04$ is derived. The result shows a deviation from the $\Delta T = 0$ isotopic spin selection rule for Fermi transitions.

539.16

2635 DECAY SCHEMES OF C^{15}, N^{16}, AND O^{19}.
D.E.Alburger, A.Gallmann and D.H.Wilkinson.
Phys. Rev., Vol. 116, No. 4, 939-49 (Nov. 15, 1959).

An iron-free intermediate-image spectrometer was used to measure the beta-ray spectra of 2.25 sec C^{15}, 7.4 sec N^{16}, and 29 sec O^{19} and to measure the positron–electron internal pair conversion lines occurring in C^{15} and N^{16} decays. C^{15} emits a beta-ray branch of end-point energy 9.82 ± 0.04 MeV to the $\frac{1}{2}$- ground state of N^{15} and a branch of 4.51 ± 0.03 MeV end-point energy. Relative intensities are (32 ± 2)% (log ft = 6.0) and 68% (log ft = 4.1), respectively, and both components have the allowed shape. From pair line measurements at 1.5% resolution the C^{15} gamma-ray energy is 5.299 ± ± 0.006 MeV, and thus the inner beta-ray group leads to the upper member of the (5.276-5.305) MeV doublet level in N^{15} known from the $N^{14}(d,p)N^{15}$ reaction. The internal pair conversion coefficient derived for the 5.299 MeV line agrees best with an E1 assignment. These data require spin and parity $\frac{1}{2}+$ or $\frac{3}{2}+$ for the 5.305-MeV level in N^{15}, and spin and parity $\frac{1}{2}+$ or $\frac{3}{2}+$ for C^{15}. Taken together with other evidence it seems likely that both states are $\frac{1}{2}+$. No evidence could be found from gamma-ray measurements for the beta decay of C^{15} to other known states of N^{15}. Some comments are made on the intermediate-coupling model for A = 15. In the decay of N^{16} it was found that the 3.3 MeV beta-ray branch to the 7.11 MeV level in O^{16} is <11% per decay, based on the Kurie-plot analysis. A value of (4.7 ± 0.9)% per decay for this branch is derived from the intensity of the 7.11 MeV pair line. O^{19} decays with beta-ray branches of 4.601 ± 0.015 MeV [(41.5^{+6}_{-8})%, log ft = 5.4] and 3.25 ± 0.02 MeV (58.5%, log ft = 4.5). Other results include a value of 5.416 ± ± 0.015 MeV for the beta-ray end-point energy of F^{20} and a value of 6.051 ± 0.005 MeV for the energy of the pair-emitting state of O^{16}

539.16

2636 BETA DECAY OF Cd^{115m}.
O.E.Johnson and W.G.Smith.
Phys. Rev., Vol. 116, No. 4, 992-5 (Nov. 15, 1959).

The decay of Cd^{115m} was studied by using NaI(Tl) scintillation counters and a 4π beta scintillation spectrometer. The following gamma rays were observed: 0.485 ± 0.007, 0.935 ± 0.014, 1.14 ± 0.017, and 1.29 ± 0.019 MeV. The 0.485 and 0.935 MeV gammas were found to be in coincidence. There were no gammas in coincidence with the 1.29 MeV gamma. The end-point energy of the ground state beta transition was determined to be 1.631 ± 0.016 MeV. The shapes and end-point energies of the beta groups in coincidence with the 0.935 and the 1.29 MeV gammas were measured. The former has a $\Delta I = 2$, yes, character; and the latter appears to have an allowed or statistical shape; the end-point energies are 0.687 ± 0.008 and 0.335 ± 0.010 MeV, respectively.

539.16

2637 THEORY OF THE VECTOR INTERACTION WITH A CONSERVED CURRENT AND THE BETA DECAY OF Na^{24}-Al^{24} NUCLEI. C.C.Bouchiat.
Phys. Rev. Letters, Vol. 3, No. 11, 516-18 (Dec. 1, 1959).

A method is proposed for testing the validity of the conserved vector current interaction hypothesis in $\beta^{\pm}$ decay of nuclei, independently of any particular nuclear model. If this hypothesis is true, the anisotropy coefficient for the direction of the polarized gamma ray following the β^- decay of Al^{24} to the T = 0, J = 4+ level, of Mg^{24} is shown to be equal in magnitude and opposite in sign to the similar coefficient for the β^+ decay of Na^{24} to the same level, which has been measured.
E.J.Squires

539.16

2638 THE β-DECAY OF ^{234}Pa(UZ).
P.W.De Lange, H.Schneider and J.W.L.De Villiers.
Nuovo Cimento, Vol. 14, No. 4, 681-703 (Nov. 16, 1959).

The β- and γ-ray spectra observed in the decay of UZ (6.66 hr) were investigated. Results of $\beta-\gamma$-coincidence measurements are given. $\gamma-\gamma$-coincidences obtained with selected γ-photopeaks in a scintillation unit are discussed. A decay scheme involving 6 β-transitions and 39 γ-transitions is presented. It is proved that UZ is the ground state of Pa^{234} with UX2 (22 ± 12) keV above it. A spin of 6^- for UZ is explained in terms of Nilsson states.

539.16

2639 DECAY OF SAMARIUM-153.
M.C.Joshi, B.N.Subbarao and B.V.Thosar.
Proc. Indian Acad. Sci. A, Vol. 45, No. 6, 390-401 (June, 1957).

Radiations emitted in the decay of Sm^{153} have been studied in

the Siegbahn-Slätis β-ray spectrometer. Using the internal conversion electron spectrum and the photo-electron spectrum with tin as radiator, the internal conversion coefficient a_K has been determined for 102 keV and 70 keV γ-rays. The relative intensities of the three β-ray branches have been determined. A weak γ-ray of energy 83 keV has been found and can be interpreted as a transition to the ground state from the first rotational level in Eu^{153}. The multipole order and character of the 102 keV transition is discussed.

539.16

2640 MEASUREMENT OF LONGITUDINAL POLARIZATION OF β-ELECTRONS FROM ^{204}Tl BY MEANS OF DOUBLE COULOMB SCATTERING.
M.Bernardini, P.Brovetto, S.Ferroni and A.Pasquarelli.
Nuovo Cimento, Vol. 14, No. 4, 787-95 (Nov. 16, 1959).

The observed effect is lower (by about 10%) than expected for -v/c polarized electrons. The results agree, within the errors, with those obtained in a previous work by measuring the circular polarization of the bremsstrahlung γ-rays.

539.16

2641 MEASUREMENT OF THE L/K-CAPTURE RATIO IN Fe^{55} DECAY. J.Scobie, R.B.Moler and R.W.Fink.
Phys. Rev., Vol.116, No.3, 657-60 (Nov. 1, 1959).

The L and K X-radiations of manganese resulting from orbital-electron capture in a gaseous source of Fe^{55} were studied in a multiwire proportional counter. The L/K-capture ratio was found to be 0.108 ± 0.006, in good agreement with the theoretical value.

539.16

2642 THE K-LL AUGER SPECTRUM OF $_{62}Sm^{150}$
G.T.Ewan, R.L.Graham and L.Grodzins.
Canad. J. Phys., Vol.38, No.2, 163-7 (Feb., 1960).

The K-LL Auger spectrum of $_{62}Sm^{150}$ has been studied in the Chalk River high-resolution β-ray spectrometer with a proportional counter detector. Seven lines were observed in the Auger spectrum with the following energies and relative intensities:

Energy (keV)	31.20 ±.02	31.62 ±.02	32.01 ±.02	32.19 ±.02	32.25 ±.02	32.61 ±.02	33.22 ±.02
Relative intensity	1.0 ±.05	1.39 ±.06	0.26 ±.06	0.18 ±.06	0.29 ±.09	3.14 ±.13	1.39 ±.06

These measurements are compared with the theoretical predictions of Asaad and Burhop. The measured energies are ~50-60 eV higher than their predictions. Discrepancies exist in the relative intensities but these are smaller than were observed at Z = 94.

539.16

2643 TRANSVERSE POLARIZATION IN ALLOWED β TRANSITIONS. R.H.Good Jr and M.E.Rose.
Nuovo Cimento, Vol. 14, No. 4, 872-86 (Nov. 16, 1959).

In an allowed β-transition, in which the recoil direction is observed in coincidence with the β-particle, it is possible under appropriate circumstances to produce completely polarized electrons. For pure Fermi transitions no additional conditions need be imposed. For Gamow–Teller transitions it is also necessary that the nucleus be oriented and, if the alignment is zero, the nuclear polarization must have the maximum possible value consistent with this condition, namely $\frac{2}{3}$. Also, in a Gamow–Teller transition from a completely polarized nucleus to a nucleus with one lower spin-value, the electron polarization is complete even without observation of the recoil. In general, the polarization of the β-particle is at least partly transverse. The conditions for purely transverse polarization are investigated. For Fermi transitions, where the transverse polarization would have unit value, this can be accomplished at any energy but the effect can be observed, in principle, only for mono-energetic electrons. In practice the energy band can be rather broad without seriously changing the nature of the polarization. For transitions with an appreciable Gamow–Teller contribution and no nuclear polarization, the β-particle polarization is not only incomplete but can be made purely transverse only at undesirably low energies. It is possible, however, to produce appreciable transverse polarization at higher energies even when the longitudinal polarization is not small. In an appendix a discussion is given of the appropriate form of the electron–positron polarization operator.

539.16 : 539.12

2644 POLARIZATION OF RaE ELECTRONS AND TIME REVERSAL INVARIANCE.
A.I.Alikhanov, G.P.Eliseev and V.A.Lyubimov.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1061-2 (Oct., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 740-1 (April, 1959).

Measurements were made of the longitudinal polarization of RaE electrons emitted from a mixed (RaD + RaE) source at average energies of 125 and 390 keV, the values obtained being $-\langle\sigma\rangle c/v = 0.733 \pm 0.06$ and 0.725 ± 0.06 respectively. These values confirm the hypothesis invoked by Yamada to explain the anomalous β-spectrum of RaE. The results indicate that the maximum possible time reversal invariance is less than 7.5%.

A.E.I. Research Laboratory

539.16

2645 TIME REVERSAL AND POLARIZATION OF RaE ELECTRONS. H.Wegener.
Z. Phys., Vol. 154, No. 5, 553-63 (1959). In German.

The polarization of electrons emitted from RaE are measured for electron energies of various values between 120 and 290 keV. A value of $-(0.75 \pm 0.02)$ is found for the polarization. From an analysis of the results one can gain information about the time reversibility of the β-decay interaction. If this assumed to be of the V-A form, with $C_i = C_i'$, this experiment measures the phase Θ between the possibility complex coupling constants C_A and C_V. The result obtained is $\Theta = (1.6 \pm 8)^\circ$ where $\Theta = 0$ means time reversal invariance.

E.J.Squires

539.16

2646 ON THE 1409 keV TRANSITION IN Sm^{152}.
S.K.Bhattacherjee, S.Raman and B.Sahai.
Nuovo Cimento, Vol.13, No.5, 1053-4 (Sept. 1, 1959).

Using scintillation counter coincidence technique it has been established that the γ-rays of energy 121.8 keV and 1409 keV following electron capture in Eu^{152} are in coincidence. These are attributed to a cascade from a level in Sm^{152} at 1531 keV through the level at 121.8 keV. This results corrects that previously reported (Abstr. 1918 of 1958).

R.E.Meads

539.16

2647 CONVERSION ELECTRON SPECTRUM OF Np^{239} AND LEVEL SCHEME OF Pu^{239}.
G.T.Ewan, J.S.Geiger, R.L.Graham and D.R.MacKenzie.
Phys. Rev., Vol. 116, No. 4, 950-9 (Nov. 15, 1959).

The conversion electron spectrum of Np^{239} was studied at resolution settings of 0.1% and 0.05% with a 100-cm radius air-cored $\pi\sqrt{2}$ β-ray spectrometer, using a proportional counter as detector. One hundred and forty-three lines were identified corresponding to Auger transitions or the internal conversion of γ-rays of energies 44.65, 49.41, 57.26, 61.46, 67.86, 88.06, 106.14, 106.47, 181.7, 209.8, 226.4, 228.2, 254.4, 272.9, 277.6, 285.5, 315.9, and 334.3 keV. The results require the addition of a level at 163.75 keV to the basic level scheme for Pu^{239} proposed by Hollander et al. in order to account for three of the weak gamma transitions observed in this work. The relative conversion line intensities are used to determine the transition multipolarities, mixing ratios and expected quantum intensities assuming the K and L shell theoretical conversion coefficients of Sliv. The precisely determined level spacings and the relative transition probabilities are compared in some detail with those expected from an interpretation of the Pu^{239} level scheme in terms of the "unified model". New and more accurate K, L, M, and N electron subshell binding energies for Pu were also deduced. These values are 20 to 100 eV higher than the values tabulated by Hill, Church, and Mihelich, which were estimated by extrapolation from data at lower Z.

539.16

2648 INVESTIGATION OF CONVERSION ELECTRON SPECTRA OF NEUTRON-DEFICIENT ISOTOPES OF LUTECIUM. V.M.Kel'man, R.Ya.Metskhvarishvili, B.K.Preobrazhenskii, V.A.Romanov and V.V.Tuchkevich.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1309-10 (Nov., 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 914-15 (May, 1959)

Measurements are reported on the conversion-electron spectra of Lu^{169}, Lu^{170}, Lu^{171}, Lu^{172} and Lu^{173}, obtained by bombarding a tantalum target with 660 MeV protons. Due to the similarity of the half-lives of Lu^{169} and Lu^{170} a unique assignment of the transition was not possible in this case, tentative classifications only being given. For Lu^{171} and Lu^{172} a table is given showing the γ-ray energies of the transitions.

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539.16

2649 MEASUREMENT OF THE POLARIZATION OF INTERNAL CONVERSION ELECTRONS.
V.A.Lyubimov and M.E.Vishnevskii.
Zh. eksper. teor. Fiz., Vol. 35, No. 6(12), 1577-9 (Dec., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 6, 1103-4 (June, 1959).

The polarization of the internal conversion electrons following the β-decay of Hg^{203} has been measured. The results indicate the spin $\frac{1}{2}$ for the ground state of Hg^{203}. W.A.Hepner

539.16

2650 TRANSITION INTENSITIES AND CONVERSION COEFFICIENTS IN Dy^{160}. M.A Clark.
Canad. J. Phys., Vol.38, No.2, 262-71 (Feb., 1960).

K-conversion coefficients for gamma transitions in Dy^{160} have been measured and the transition multipolarities determined as follows (E_γ, α_K, multipolarity); 86.7 keV, 1.5(E2); 197 keV, 1.6×10^{-1}(E2); 216 keV, 4.0×10^{-2}(E1); 299 keV, 1.3×10^{-2}(E1); 880 keV, 3.1×10^{-3}(E2); (962 + 966) keV, 2.5×10^{-3}(E2); 1179 keV, 6.6×10^{-4}(E1); 1205 keV, 4.6×10^{-4}(E1); 1273 keV, 6.1×10^{-4}(E1); 1315 keV, 3.9×10^{-4}(E1). Relative transition intensities are compared with the predictions of the Unified Model of Bohr and Mottelson and the asymmetric rotor theory of Davydov and Filippov. Transition intensities from the 966-keV level to members of the ground state rotational band suggest the astmmetric rotor interpretation.

539.16

2651 CIRCULAR POLARIZATION OF INTERNAL γ-BREMSSTRAHLUNG IN β-DECAY AND TIME-REVERSAL INVARIANCE. R.Yu.Volkovyskii.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 811-12 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 562-3 (March, 1959).

Expressions are given for the electron—neutrino—photon angular correlation, and for the electron—photon correlation from oriented nuclei, for right or left circular polarization of the photon in both cases. J.C.Taylor

539.16

2652 MEASUREMENT OF β—γ CORRELATION FROM ORIENTED NUCLEI. A.V.Kogan, V.D.Kul'kov, L.P.Nikitin, N.M.Reinov, I.A.Sokolov and M.F.Stel'makh.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1295-6 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 5, 903-5 (May, 1959).

An apparatus is described which permits an increase in the duration and statistical accuracy of correlation experiments at low temperatures. S.J.St-Lorant

539.16

2653 STUDIES WITH SCINTILLATION COINCIDENCE SPECTROMETER: Se^{75} AND Sb^{125}. G.Chandra.
Proc. Indian Acad. Sci. A, Vol. 46, No.5, 360-6 (Nov., 1957).

Cascade relationships between gamma-transitions in the decay of Se^{75} and Sb^{125} have been investigated with the help of a scintillation coincidence spectrometer. A decay scheme for Se^{75} has been proposed.

539.16

2654 THE HARD γ-RADIATION OF Ag^{110*}.
L.V.Gustova, L.P.Timofeeva and O.V.Chubinskii.
Zk. eksper. teor. Fiz., Vol.35, No.5(11), 1317-18 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol.35(8), No.5, 920-1 (May, 1959).

Describes the mapping of the γ-spectrum of Ag^{110*} using a gamma-hodoscope, over an energy range of 1.7-2.5 MeV and magnetic field strengths from 700-865 Oe. S.J.St-Lorant

539.16

2655 CONICAL POLARIMETER FOR γ-RAYS: β—γ CIRCULAR POLARIZATION CORRELATION MEASUREMENTS OF Au^{198}. J.P.Deutsch and P.Lipnik.
Ann. Soc. Sci. Bruxelles I, Vol. 73, No. 3, 420-31 (1959). In French.

A non-cylindrical device for the measurement of gamma-ray circular polarization is presented. A figure of merit is computed to compare different polarimetric devices. The present polarimeter has high figure of merit, except in the very low energy region ($E < 300$ keV), where Steffen-type polarimeters are to be preferred. Preliminary results of beta—gamma correlation measurements on Au^{198} are presented. The value $A = 0.45 \pm 0.11$ obtained agrees with other results.

539.16

2656 ANGULAR CORRELATION OF Cd^{114} GAMMA RAYS IN SINGLE CRYSTALS OF INDIUM. A.G.Duneer, Jr.
Phys. Rev., Vol. 116, No. 4, 999-1000 (Nov. 15, 1959).

The measured values of the angular correlation function at $\theta = 150^0$ were consistent with the statistical deviation of the mean of ± 0.005 for six measurements with different azimuthal angles between the c axis of an indium metal crystal and the direction of the fixed counter. The electric field gradient at the position of the decaying Cd^{114} nucleus was calculated using a Fermi—Thomas type calculation with account being taken of the antishielding effect of the atomic core electrons.

539.16

2657 STUDIES WITH SCINTILLATION COINCIDENCE SPECTROMETER: Cs^{134}. G.Chandra.
Proc. Indian Acad. Sci. A, Vol. 44, No. 4, 194-200 (Oct., 1956).

The set-up of "Slow-Fast" coincidence scintillation spectrometer is described. γ-γ coincidences in Cs^{134} have been studied. The 604 keV γ transition is found to be in cascade with 460 ± 20, 555 ± 15, 794 ± 15 and 1349 ± 30 keV γ transitions. The 794 keV γ transition is found to be in cascade with 604 ± 10 and 555 ± 15 keV γ transitions. The results are consistent with the decay scheme of Cs^{134} proposed by Forster et al.

539.16

2658 GAMMA SPECTRUM OF Se^{81}
I.Y.Krause, W.D.Schmidt-Ott, K.W.Hoffmann and A.Flammersfeld.
Z. Phys., Vol. 157, No. 1, 106-11 (1959). In German.

The decay of Se^{81} (18 min) produced by neutron bombardment of natural Se and 98% enriched Se^{80} was studied with the aid of scintillation spectrometers. Gamma-rays were observed and could be identified as belonging to the decay of Se^{81}, revealing three excited levels in Br^{81} at (282 ± 3) keV, (565 ± 6) keV and (820 ± 10) keV. The branching ratios of the beta-components are 98.7% leading to the ground state and (0.06 ± 0.03)%, (0.85 ± 0.20)% and (0.40 ± 0.10)% leading to the excited states, respectively. The 565 keV level decays to the ground state directly or by a cascade-transition with nearly equal intensities, the 820 keV level mainly by a direct transition.

539.16 : 535.8

LIGHT SOURCES USING RADIOISOTOPES. See Abstr. 2238

NUCLEAR REACTIONS

539.17

2659 INTERACTION BETWEEN 1 GeV PROTONS AND HEAVY AND LIGHT NUCLEI. I. USING DILUTE PHOTOGRAPHIC EMULSIONS. INTERACTION CROSS-SECTIONS. REACTION MODES. G.Philbert.
J. Phys. Radium, Vol. 18, No. 12, 656-62 (Dec., 1957). In French.

Using different types of nuclear emulsions (Ilford G_5 normal and G_5 diluted) a differential statistical method has been applied to the study of the interaction of protons of 0.95 GeV with complex nuclei Ag, Br and C, N, O. The characteristic properties of diluted emulsions, in particular those concerning the ionization caused by charged particles, have been specified. The determination of the cross-sections of absorption for protons of 0.95 GeV by light nuclei (C, N, O) and heavy nuclei (Ag, Br) confirms the results obtained by the methods of transmission. The values obtained for the cross-section of elastic scattering and the angular distribution of scattered protons are in agreement with the values predicted by the theory of diffraction. Further, by means of the differential statistical method, the partial cross-section for the different types of reaction (defined by the number of charged particles emitted) with heavy and light nuclei has also been found. The results are compared with those obtained by the criterion of the potential barrier. The probability for an α particle of energy below 9 MeV to be emitted in the reaction of protons of 0.95 MeV with light nuclei does not depend noticeably on the type of reaction. From the experimental data it may also be seen that in 75% of the cases the reaction with a light nucleus produces a complete disintegration of the latter into particles of mass equal or smaller than 4. Finally some indications are given on the existence of single collisions of type proton—nucleon bound with light nuclei.

539.17 : 539.11

TIME REVERSAL IN NUCLEAR REACTIONS.
See Abstr. 2488

539.17

2660 SEARCH FOR Li^4.
S.Bashkin, R.W.Kavanagh and P.D.Parker.
Phys. Rev. Letters, Vol. 3, No. 11, 518-20 (Dec. 1, 1959).

An attempt has been made to detect positron emission from Li^4 produced by the reaction $He^3(p,\gamma)$. If Li^4 were stable against re-emission of the proton one would expect it to decay by the emission of 19 MeV positrons with a lifetime of ~ 30 millisecs. A gas cell target, surrounded by a shielded plastic scintillator, was bombarded with a pulsed beam of protons of 1.14 MeV mean energy, after correction for window and target thickness. The cell could be filled with either He^3 or He^4. The counting equipment, of detection efficiency 80% for the Li^4 positrons, was gated to count in the interval between beam pulses. No measurable change in count rate was observed on changing the target gas and an upper limit for the cross-section for the production of Li^4 of 4×10^{-31} barns was obtained, assuming a lifetime in the range 0.006 to 600 sec. Assuming s-wave proton capture and a 1^- or 2^- bound ground state for Li^4, a theoretical estimate of $\sigma > 10^{-9}$ barns has been made for the production cross-section, a factor of 25 greater than the experimental limit. The astrophysical consequences of the result in relation to the consumption of He^3 in stars are discussed.

R.E.Meads

539.17

2661 RADIATIVE PROTON CAPTURE BY O^{18}.
J.W.Butler and H.D.Holmgren.
Phys. Rev., Vol. 116, No. 6, 1485-9 (Dec. 15, 1959).

A search for gamma-emitting levels in F^{19} between 8.3 and 9.8 MeV of excitation energy was made by bombarding a NiO target (39% O^{18}) with protons over the energy range 360 to 1960 keV. Resonances in the gamma-ray yield were observed with the use of a 3 in. diameter × 3 in. sodium iodide crystal and a 20-channel pulse-height analyser. The results are as follows:

Resonance energy (keV)	Resonance width (keV)	γ-ray energies (MeV)
630 ± 2	2.6 ± 1.0	8.5 ± 0.2
849 ± 3	40 ± 5	8.5 ± 0.3, 7.2 ± 0.2, 4.8 ± 0.2, 4.3 ± 0.2(?), 2.4 ± 0.2(?)
1169 ± 2	≤ 0.9	8.8 ± 0.2, 7.7 ± 0.2, 6.27 ± 0.05, 3.67 ± 0.05, 2.59 ± 0.05, 1.24 ± 0.05
1399 ± 5	< 15	...
1685 ± 5	< 15	...
1769 ± 2	4.0 ± 1.0	9.4 ± 0.3
1931 ± 2	1.5 ± 1.0	9.8 ± 0.2, 6.45 ± 0.10

The angular distribution of the 6.27 MeV gamma-ray from the 1169 keV resonance was measured, and the results are listed in tabular form. The results of the present experiment are compared with other experiments using the $O^{18}(p,\gamma)F^{19}$, $O^{18}(p,\alpha)N^{15}$, and the $O^{18}(d,n)F^{19}$ reactions.

539.17 : 539.12

Be(p,n) REACTION AT 680 MeV. See Abstr. 2550

539.17

2662 [A NOTE] ON d–d REACTIONS.
I.Sh.Vashakidze and O.D.Cheishvili.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1062-3 (Oct., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 741-2 (April, 1959).

Discusses qualitatively the effects of "nucleon clusters" in nuclei in high-energy d–d reactions. R.J.N.Phillips

539.17

2663 ANGULAR DISTRIBUTION FOR THE DIFFRACTION SCATTERING OF DEUTERONS. I.I.Ivanchik.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1050-2 (Oct., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 733 (April, 1959).

Discusses semi-classical diffraction scattering by a "black disk" nucleus. R.J.N.Phillips

539.17

2664 VIOLATION OF THE ISOTOPIC SPIN SELECTION RULE IN THE $Ca^{40}(d,\alpha)K^{38}$ REACTION.
Y.Hashimoto and W.P.Alford.
Phys. Rev., Vol. 116, No. 4, 981-5 (Nov. 15, 1959).

Alpha particles leading to the ground state and first excited state of K^{38} in the $Ca^{40}(d,\alpha)$ reaction were observed and the excitation energy of the first excited state of K^{38} was determined as 123 ± 8 keV. The relative intensities of the groups were measured for incident deuteron energies between 3.2 and 4.1 MeV. Over this range the average intensity of the ground-state group is about 10 times that of the group to the first excited state and it is concluded that the latter is the 0^+ T = 1 analogue of the A^{38} ground state. Even in the absence of isotopic spin selection rules, the alpha transition to the 0^+ state is expected to be inhibited appreciably by selection rules on angular momentum and parity. A calculation using the statistical model of the nucleus indicates that these decrease the cross-section for the $0^+ \rightarrow 0^+$ transition by a factor of about 5 relative to that for the ground-state transition. It thus appears that the isotopic spin selection rule inhibits the transition only by a factor of about two. This breakdown of the isotopic spin selection rule can probably be attributed to Coulomb effects in the compound state. The reduction of the cross-section as a result of angular momentum selection rule is probably equally important in other (d,α) reactions that have so far been used to study isotopic spin selection rules. It appears that further experimental results are needed for an understanding of the "isotopic spin forbidden" (d,α) reactions on light nuclei.

539.17

2665 POLARIZATION OF PROTONS IN $C^{12}(d,p)C^{13}$.
R.G.Allas and F.B.Shull.
Phys. Rev., Vol. 116, No. 4, 996-8 (Nov. 15, 1959).

The polarization of protons from the ground-state $C^{12}(d,p)C^{13}$ reaction was measured over an angular range $\theta_L = 15^\circ$ to $\theta_L = 60^\circ$ at a deuteron bombarding energy of 10 MeV. The polarization was found to be positive at all angles studied, the axis of quantization being defined by $n = k_p \times k_d$. The observed polarizations were 18% at 15° (lab); 11% at 18°; 13.8% at 24°; 15.2% at 30°; 19.5% at 36°; 44.4% at 48°; 30% at 54°; 45.8% at 60°. The results are compared with existing polarization measurements on $C^{12}(d,p)C^{13}$.

539.17

2666 THREE-BODY BREAKUP; DEUTERON DISSOCIATION CROSS SECTIONS. J.E.Young.
Phys. Rev., Vol. 116, No. 5, 1201-11 (Dec. 1, 1959).

An analysis of the reaction X(d,np) has been carried out within the framework of the algebraic theory of scattering. It is possible to cast the transition matrix element governing the process into several forms. In particular, one of these, the asymmetric form, involves no nuclear interactions for one of the deuteron constituents. The other forms, so-called symmetric, contain interactions for all particle pairs and are shown to be inherently superior to the asymmetric expression. Calculations of the neutron spectrum, at zero degrees in centre of mass, for 6.3 MeV deuterons on deuterons are presented. These are done in an S-wave approximation to illuminate the theoretical discussions; and a comparison is made with experimental data. It is concluded that the theory as presented is capable of describing the dissociation reaction. Moreover, in its final form, the description involves only those interactions which are readily accessible through experiment.

539.17

2667 EXCITATION FUNCTION FOR THE $Al^{27}(d,\alpha p)Na^{24}$ REACTION BETWEEN 0 AND 28.1 MeV.
P.A.Lenk and R.J.Slobodrian.
Phys. Rev., Vol. 116, No. 5, 1229-31 (Dec. 1, 1959).

The excitation function was measured using the external beam facilities of the Buenos Aires 71 in. synchrocyclotron, together with the stacked-foil technique. Between 19 and 28.1 MeV present results are more precise than those previously obtained, showing that the maximum of the cross-section is located at 24.25 MeV with a value of 51.4 mb.

539.17

2668 SCATTERING OF 18 MeV ALPHA PARTICLES BY C^{12}, O^{16} AND S^{32}. J.C.Corelli, E.Bleuler and D.J.Tendam.
Phys. Rev., Vol. 116, No. 5, 1184-93 (Dec. 1, 1959).

The scattering of 18 MeV alpha particles by gaseous C_2H_2, O_2, and H_2S targets was studied with a multiplate scattering chamber. The elastic angular distributions exhibit the diffraction-like pattern typical of light elements. Carbon and oxygen show a sharp rise above the Rutherford cross-sections at the backward angles, with values σ/σ_R of 660 for carbon and 350 for oxygen near 173°. A good fit to the angular distribution for inelastic scattering leading to the first excited state of C^{12} (4.43 MeV, 2^+) is obtained using a $[j_2(qR)]^2$

dependence with $R = 5.5 \times 10^{-13}$ cm. No direct-interaction analysis is possible for the alpha-particle groups corresponding to the 7.65 MeV and 9.61 MeV levels in C^{12} and to the excited states of O^{16} up to the 8.87 MeV level. All these distributions show strong forward peaking. In the case of inelastic scattering by S^{32} ($Q = -2.44$ MeV), an interaction radius of 6.5×10^{-13} cm can be deduced from the angular distribution, though the agreement with $[j_2(qR)]^2$ is rather poor. A summary of elastic scattering results for elements in the range from $Z = 6$ to $Z = 47$ is presented. Expressions for the second-order geometry and the multiple-scattering corrections are given.

539.17

2669 REACTIONS OF Cu^{63} AND Cu^{65} WITH ALPHA PARTICLES. N.T.Porile and D.L.Morrison.
Phys. Rev., Vol. 116, No. 5, 1193-200 (Dec. 1, 1959).

Excitation functions were measured for the (α,n), $(\alpha,2n)$, and $(\alpha,\alpha n)$ reactions on Cu^{63} and Cu^{65}, as well as for the $Cu^{63}(\alpha,pn)$, $Cu^{65}(\alpha,2p)$, and $Cu^{65}(\alpha,2\alpha)$ reactions, for incident alpha particles of 15-41 MeV. The excitation functions for the (α,n), $(\alpha,2n)$, and (α,pn) reactions go through much sharper maxima than the excitation functions for the $(\alpha,\alpha n)$ reactions. Cross-sections for the $(\alpha,2p)$ and $(\alpha,2\alpha)$ reactions increase monotomically with bombarding energy and attain values of 2.7 and 2.1 mb at 40 MeV, respectively. The value of $\sigma(\alpha,pn)/\sigma(\alpha,2n)$ for Cu^{63} in the region of maximum yield is 3.3. The maximum cross-sections measured for the $(\alpha,\alpha n)$ reactions are 205 mb and 143 mb for Cu^{63} and Cu^{65}, respectively. The effects on the observed cross-sections of neutron and proton binding energy differences, and of level density differences in the residual nuclei have been considered. The effect of these factors is in accord with the predictions of the statistical theory for the (α,n) and $(\alpha,2n)$ reactions but not for the $(\alpha,\alpha n)$ reaction. A method for monitoring the energy of the incident beam based on the variation with energy of the ratio of cross-sections for several of the above reactions is described.

539.17 : 539.12

NEUTRON POLARIZATION IN $T(d,n)He^4$ REACTIONS. See Abstr. 2549

539.17 : 539.14

HE^3 INDUCED REACTIONS ON B^{11}, C^{12}, C^{13}, N^{14}, AND O^{16}. See Abstr.2624

539.17

2670 DIFFRACTION BREAKUP OF LIGHT NUCLEI. A.G.Sitenko and Yu.A.Berezhnoi.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1289-91 (Nov., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 5, 899-901 (May, 1959).

The diffraction (by heavy nuclei) of light nuclei,which consist of two loosely bound parts, is similar to the diffraction of deuterons. Some examples of the latter are discussed, for an arbitrary ratio of nuclear and deuteron radii. R.J.N.Phillips

539.17

2671 ELASTIC SCATTERING OF O^{16} FROM NUCLEI. J.A.McIntyre, S.D.Baker and T.L.Watts.
Phys. Rev., Vol. 116, No. 5, 1212-20 (Dec. 1, 1959).

O^{16} nuclei were elastically scattered from Au^{197}, Ni (natural isotope abundance), Al^{27}, and C^{12} at a laboratory energy of 158 MeV. The angular distributions obtained show features similar to those obtained for alpha particles scattered from various nuclei. However, diffraction effects are evident for target nuclei of higher atomic number Z with the alpha particle as the bombarding nucleus than with O^{16} as the bombarding nucleus. A survey of the literature is presented to show that diffraction effects become evident for $\eta \sim < 5$, where $\eta = ZZ'e^2/\hbar v$.

539.17

2672 THE RATIO OF THE EFFECTIVE CROSS-SECTIONS FOR THE (e,n) AND (γ,n) PROCESS. R.Rodenberg.
Z. Phys., Vol. 158, No. 1, 42-76 (1960). In German.

The ratio is derived using the relativistic Coulomb eigenfunctions for the continuous spectrum, as used by Sommerfeld—Maue (1935) and Bethe—Maximon (Abstr. 4603 of 1954). Only the electric and magnetic dipole transitions are considered. For these, the Coulomb correction to the Born approximation is calculated. The result of an estimation of the electric quadrupole transition is given. The effect of screening and that of finite nuclear size are estimated. With this ratio one is able to calculate the cross-sections for the (e,n) and (γ,n) process using the experimental values of only one of these quantities.

539.17

2673 POLARIZATION CORRELATION FOR THE COULOMB SCATTERING OF ELECTRONS AND μ-MESONS ON LIGHT NUCLEI INCLUDING RADIATIVE CORRECTIONS. I.G.Ivanter.
Zh. eksper. teor. Fiz., Vol. 36, No. 1, 325-6 (Jan., 1959). In Russian.

The effect is calculated in the second Born approximation by using the method of projection operators and it is shown that there is hope for an experimental check on the radiative correction term. Also an error in Tolhoek's work (Abstr. 3359 of 1957) is pointed out. P.Roman

539.17

2674 THE (γ,α) PHOTOEFFECT IN Ba,Ce,Nd and Sm. F.I.Havliček.
Nuovo Cimento, Vol.13, No.5, 969-73 (Sept. 1, 1959). In German.

These reactions were investigated by measuring the tracks in nuclear plates. The γ rays used were bremsstrahlung of energies up to 30 MeV. In the case of samarium, which cannot decay to an isotope with 82 neutrons, the cross-section was considerably smaller than in the other cases. J.A.Evans

539.17

2675 ON THE SURFACE EFFECT IN NUCLEAR PHOTO-REACTIONS. V.De Sabbata and A.Tomasini.
Nuovo Cimento, Vol. 13, No. 6, 1268-72 (Sept. 16, 1959).

A calculation is made of the differential cross-section for the production of neutrons by γ-bombardment of oxygen and calcium. The matrix elements are obtained by integration of nuclear shell-model wave-functions, from a mean radius $\underline{R}$ up to infinity. The final neutron state is taken to be a plane wave. Results are given for various γ-ray energies, and for two choices of $\underline{R}$. E.J.Squires

539.17

2676 OBSERVATIONS ON THE PHOTODISINTEGRATION OF ^{16}O THROUGH THE INVERSE PROCESS $^{15}N(p,\gamma)^{16}O$. N.W.Tanner, G.C.Thomas and W.E.Meyerhof.
Nuovo Cimento, Vol. 14, No. 1, 257-9 (Oct. 1, 1959).

The (p,γ) reaction in N^{15} was investigated using a calibrated NaI crystal, and an excitation curve was taken at 90° to the proton beam. The result was compared with those obtained by detailed balance from the O^{16} photodisintegration results of Johansson and Forkman, (Abstr. 6319 of 1958) and the agreement was very close. Comparison was also made with the theoretical work of Elliot and Flowers (Abstr. 717 of 1958). J.A.Evans

539.17

2677 ON THE POSSIBILITY OF APPLYING THE BELEN'KII—TAMM EQUILIBRIUM SPECTRUM TO THE DETERMINATION OF THE EXCITATION FUNCTIONS OF THE (γ,n) REACTIONS. V.A.Shkoda-Ul'yanov.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1041-2 (Oct., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 4, 726-7 (April, 1959).

A method is proposed for measuring photoneutron cross-sections in the energy range 25-100 MeV (previous methods involved large errors). The proposed method uses the equilibrium photon spectrum obtained when a monoenergetic beam of electrons falls on a sufficiently thick target. It is shown how the photoneutron cross-section can be obtained from the neutron yield. E.J.Squires

539.17

2678 RELATIVE MEASUREMENT OF THE INTEGRATED EFFECTIVE CROSS-SECTIONS FOR THE NUCLEAR PHOTO-EFFECT : REACTIONS ON Ca^{40}. K.H.Lindenberger and J.A.Schoer.
Z. Phys., Vol.158, No.1, 111-19 (1960). In German.

Metallic calcium was irradiated by 29 and 34 MeV bremsstrahlung. Yields of the induced activities was obtained relative to the reaction $C^{12}(\gamma,n)C^{11}$ by measuring the annihilation quanta with a NaI-spectrometer. The sum of the cross-section integrated to 33 MeV for the reactions $Ca^{40}(\gamma,n)Ca^{39}$, $Ca^{40}(\gamma,2n)Ca^{38}$, $Ca^{40}(\gamma,np)K^{38m}$, and $Ca^{40}(\gamma,np)K^{38}$ was determined to be 116 ± 17 MeV mb. At

29 MeV maximum energy the branching ratio $Ca^{40}(\gamma,np)K^{38m}$ to $Ca^{40}(\gamma,np)K^{38}$ was found to be > 4. As a byproduct the half-lives of Ca^{39}, K^{38m} and S^{35} were observed to be 0.873 ± 0.0008 sec, 0.944 ± 0.012 sec and 2.61 ± 0.05 sec, respectively.

539.17

2679 THE GAMMA-NEUTRON CROSS SECTION FOR N^{14}.
J.D.King, R.N.H.Haslam and R.W.Parsons.
Canad. J. Phys., Vol. 38, No. 2, 231-9 (Feb., 1960).

The reaction N^{14} $(\gamma,n)N^{13}$ has been studied by irradiating dicyandiamide in the X-ray beam of a 25-MeV betatron and measuring the residual activity with a sodium iodide crystal system. The photoneutron cross-section shows maxima at 11.7, 13.2, 15.2, 19.5, and 22.8 MeV, the last two being in the giant resonance region. The integrated cross-section from threshold to the beginning of the giant resonance region is 1.8 MeV-mb, and this is compared with a recent theoretical prediction. During the course of the experiment, accurate measurements were made of the half-life of N^{13} and it was found to be 9.93 ±0.05 minutes.

539.17

2680 ENERGY DEPENDENCE OF FAST-NEUTRON ACTIVATION CROSS SECTIONS.
A.E.Johnsrud, M.G.Silbert and H.H.Barschall.
Phys. Rev., Vol. 116, No. 4, 927-36 (Nov. 15, 1959).

Fast-neutron capture cross-sections of 24 nuclides ranging from A = 51 to A = 197 were measured by an activation method, in the neutron energy region from 0.15 to 6.2 MeV. The neutron energy spreads were of the order of 0.1 MeV, so that cross-sections averaged over many energy levels of the compound nucleus were measured. Activities induced in samples by fast and thermal neutrons were compared. The relative neutron flux in the fast- and thermal-neutron activations were determined with a U^{235} fission counter. A knowledge of the energy dependence of the U^{235} fission cross-section and of the thermal-neutron activation cross-sections allows calculation of the fast-neutron activation cross-sections.

539.17

2681 CALCULATIONS OF NEUTRON CAPTURE CROSS SECTIONS.
C.Mossin-Kotin, B.Margolis and E.S.Troubetzkoy.
Phys. Rev., Vol. 116, No. 4, 937-8 (Nov. 15, 1959).

Neutron capture cross-sections are calculated for a number of target nuclei using the statistical theory of nuclear reactions. These calculations are compared with experiment (see preceding abstract). The different shapes of these capture cross-sections as a function of energy are explained in terms of the effect of higher incident neutron partial waves and the competition from inelastic scattering. Using the measured capture-sections it is seen that considerable information can be extracted concerning properties of the target and compound nuclei.

539.17

2682 GAMMA RAYS ACCOMPANYING THE INELASTIC SCATTERING OF 3 MeV NEUTRONS.
A.L.Androsenko, D.L.Broder and A.I.Lashuk.
Atomnaya Energiya, Vol. 7, No. 3, 268-71 (Sept., 1959). In Russian.

Neutrons from the D(d,n)He^3 reaction were incident on Ti, Cr, Sr, I, Ba, W, Ir, and Bi targets placed on a NaI(Tl) crystal connected to a scintillation γ-spectrometer. The background given by a carbon target was subtracted for energies above 0.3 MeV. The γ spectra are tabulated, and those for Sr, Ba, W and Ir are shown graphically. J.B.Sykes

539.17

2683 MEASUREMENT OF RADIATIVE CAPTURE RESONANCE INTEGRALS IN A THERMAL REACTOR SPECTRUM, AND THE THERMAL CROSS SECTION OF Pu-240.
W.H.Walker, C.H.Westcott and T.K.Alexander.
Canad. J. Phys., Vol. 38, No. 1, 55-77 (Jan., 1960).

An apparatus is described which detects γ-rays emitted by a thin target placed in a well-defined neutron beam. It has been used to determine the Cd ratios of Au and Pu^{240}, from which the ratio of the resonance integral to the 2200 m/s cross-section for radiative neutron capture in Pu^{240} has been deduced, using Au as a reference standard. Using this ratio and previously measured values of the resonance integral of Pu^{240} and its effective cross-section in two positions in the NRX reactor, three separate estimates of the 2200 m/s cross-section of Pu^{240} have been made. The mean value is 270 ± 17 barns. In an auxiliary experiment to indicate the shape of the epithermal spectrum of the neutron beam, the activation Cd ratios of Mn and In were compared with that of Au. These results, combined with the known 2200 m/s capture cross-sections of these nuclides, yield new values of the radiative capture resonance integrals for both Mn and In.

539.17

2684 CONSERVATION OF PARITY IN STRONG INTERACTIONS. R.Haas, L.B.Leipuner and R.K.Adair.
Phys. Rev., Vol. 116, No. 5, 1221-5 (Dec. 1, 1959).

An investigation was made of the angular distribution of the gamma rays produced by the capture of slow polarized neutrons in cadmium, indium, and silver. The portion of the intensity of the transitions from the spin-one capture state of Cd^{114} to the spin-zero ground state and spin-two first excited state, which is proportional to $\cos\theta$, where θ is the angle between the neutron spin and the direction of propagation of the gamma ray, was measured to be less than one part in 10^3. From this result the conclusion is reached that the intensity of the odd-parity part of the neutron capture state is less than 2×10^{-9} times as large as the even-parity part, and that the parity-nonconserving part of nuclear forces is less than 10^{-8} times as strong as the parity-conserving part. Qualitatively similar, though weaker, conclusions were derived from the measurements on silver and indium.

539.17

2685 COMPOUND-ELASTIC SCATTERING OF 4.2-MeV NEUTRONS IN LEAD. P.L.Okhuysen and J.T.Prud'homme.
Phys. Rev., Vol.116, No.4, 986-9 (Nov. 15, 1959).

Measurements of the differential elastic scattering cross-sections of normal lead and radiolead (88% Pb^{206}) for 4.2 ± 0.1 MeV neutrons show a marked difference. Within experimental error this difference appears to be isotropic. It is concluded that the difference is due to compound-elastic scattering in Pb^{206}.

539.17 : 548.5 : 539.2

USE OF REACTION $B^{10}(n,\alpha)Li^7$ FOR IRRADIATION.
See Abstr. 1610

539.17

2686 SCATTERING OF μ MESONS FROM LEAD NUCLEI.
B.Chidley, P.Goldstein, G.Hinman, R.Summers and R.Adler.
Phys. Rev., Vol. 116, No. 4, 1015-21 (Nov. 15, 1959).

The angular distribution of 23 MeV μ mesons scattered by lead nuclei was measured by using a counter arrangement and also by using a propane bubble chamber. The results agree, to the accuracy of the experiments, with the distribution predicted by the ordinary Coulomb interaction of the μ-meson and the lead nucleus.

539.17

2687 ANGULAR DISTRIBUTION OF NEUTRONS FOLLOWING THE NUCLEAR CAPTURE OF POLARIZED MUONS.
A.Astbury, I.M.Blair, M.Hussain, M.A.R.Kemp, H.Muirhead and R.G.P.Voss.
Phys. Rev. Letters, Vol. 3, No. 10, 476-8 (Nov. 15, 1959).

An asymmetry of the neutrons emitted when polarised μ^--mesons are captured in a nucleus would indicate the non-conservation of parity in the capture process. An experiment with a sulphur target to determine the value of α, the asymmetry parameter, showed that it was certainly not zero. A value of about -0.4 is reported, subject to some uncertainty. Possible theoretical interpretations of this result are discussed. S.J.Goldsack

539.17

2688 ELASTIC SCATTERING OF 5-22 MeV POSITIVE PIONS BY CARBON.
V.G.Kirillov-Ugryumov, L.P.Kotenko, E.P.Kuznetsov and F.M.Sergeev.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1300-2 (Nov., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 5, 907-9 (May, 1959).

A 750 cm^3 propane bubble chamber was used, the pions being identified by $\pi \rightarrow \mu \rightarrow e$ decay. After appropriate corrections for Coulomb scattering, hydrogen content, and other effects 31 pions out of 5675 were found to have undergone elastic nuclear scattering on carbon. The resultant cross-sections are:

5-8 MeV	402 ± 152	millibarns
8-15 "	78 ± 45	"
15-22 "	56 ± 32	"
5-22 "	97 ± 27	"

A.Ashmore

539.17

2689 DETERMINATION OF THE MOMENTUM AND EXCITATION ENERGY ACQUIRED BY A HEAVY NUCLEUS ON INTERACTION WITH A FAST NUCLEON.
A.I.Obukhov.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1042-4 (Oct., 1958).
In Russian. English translation in Soviet Physics—JETP (New York), Vol. 35(8), No. 4, 727-8 (April, 1959).

Determination of the mean value of the parallel and perpendicular components of the momentum of the struck nucleus, after the emission of cascade particles, was carried out. 660 MeV protons incident on uranium nuclei were used and fission fragments were detected in nuclear emulsions. It is assumed that the angular distribution of fission fragments is isotropic in the system of the nucleus undergoing fission. C.J.Batty

539.17 : 539.16

2690 ALPHA DECAY AND FISSION OF ALIGNED NUCLEI.
N.R.Steenberg and R.C.Sharma.
Canad. J. Phys., Vol.38, No.2, 290-314 (Feb., 1960).

The theory of the angular distribution of alpha particles of fission fragments from nuclei aligned at low temperatures is presented. Very explicit results are obtained in the high temperature approximation. These are directly dependent upon the branching which takes place to the various allowed partial waves. This branching is influenced by the nuclear shape, but it is shown that for this problem the effect of penetrating a spheroidal barrier is not critical. An application is made to the experimental work so far available and the result is reasonably satisfactory.

539.17 : 539.12

2691 COMPUTING THE SPECTRA OF FISSION NEUTRONS.
V.P.Kovalev and V.S.Stavinskii.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 787-9 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 545-7 (March, 1959).

The spectra of fission neutrons are calculated taking into account the energy dependence of the neutron capture cross-section. A "black" nucleus model is considered to give a satisfactory description of the cross-section It is assumed that the neutrons are emitted isotropically in the centre-of-mass system of the moving fragments and that the level density obeys Weisskopf's law over the whole interval of excitation energy. Calculations for U^{235} and Cf^{252} are in good agreement with experiment. J.D.Dowell

539.17 : 537.56

IONIZATION YIELDS FOR FISSION FRAGMENTS.
See Abstr. 2322

539.17

2692 A DETERMINATION OF THE RATIO OF EFFECTIVE FISSION CROSS-SECTIONS FOR Pu^{239} AND U^{235} IN SLUGS IN URANIUM-WATER LATTICES.
V.P.Katkov, Y.V.Nikolsky and G.A Stolyarov.
J. nuclear Energy, Vol. 4, No. 1, 128-32 (Jan., 1957). English translation of article in: Atomnaya Energiya, Vol. 1, No. 3, 61 (1956).

The ratio of the mean fission cross-sections of Pu^{239} and U^{235} was determined in natural uranium—ordinary water lattices. For comparison the ratio was also measured in a uranium-graphite reactor. The effective fission cross-section ratios Pu/U in uranium-water lattices with 45, 50, 55, and 60 mm pitch, and in the uranium-graphite reactor with 200 mm lattice pitch were found to be 2.24, 1.99, 1.88, 1.79, and 1.79 respectively.

539.17

2693 THE NUMBER OF NEUTRONS EMITTED BY Pu^{239} UPON THERMAL- AND EPITHERMAL-NEUTRON-INDUCED FISSION.
V.I.Kalashnikov, V.I.Lebedev, L.A.Mikaelyan and M.I.Pevzner.
J. nuclear Energy, Vol. 4, No. 1, 67-9 (Jan., 1957). English translation of article in: Atomnaya Energiya, Vol. 1, No. 3, 11 (1956).

The mean number ν of neutrons emitted during the fission of Pu^{239} by thermal and epithermal (0.15 to 0.5 eV) neutrons has been measured, and found to be the same within 2% for both cases.

539.17 : 539.12

2694 RELATIVE YIELDS OF DELAYED NEUTRONS IN FISSION OF U^{238}, U^{235}, AND Th^{232} BY FAST NEUTRONS.
B.P.Maksyutenko.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 815-16 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 565-7 (March, 1959)

Each sample was irradiated by 15, 3.3 or 2.4 MeV neutrons, then moved to a neutron counter. Five groups of delayed neutrons, corresponding to decay times of about 55, 22, 6, 2, and 0.6 sec were resolved in each case. The relative yields in each group are tabulated. D.W.L.Sprung

539.17

2695 THE CROSS-SECTION FOR U^{238} FISSION BY FISSION NEUTRONS. R.B.Leachman and H.W.Schmitt.
J. nuclear Energy, Vol. 4, No. 1, 38-43 (Jan., 1957)

The cross-section for U^{238} fission by neutrons from the thermal-neutron-induced fission of U^{235} has been measured to be $(0.756 \pm 0.008)/\nu$ barn, where ν is the average number of neutrons emitted per U^{235} fission. Used with the most recent value of ν for U^{235}, $\nu = 2.46 \pm 0.03$, this gives 0.307 ± 0.005 barn for the U^{238} fission cross-section.

539.17

2696 ABSOLUTE YIELDS OF THE XENON AND KRYPTON ISOTOPES IN U^{238} SPONTANEOUS FISSION.
B.G.Young and H.G.Thode.
Canad. J. Phys., Vol. 38, No. 1, 1-9 (Jan., 1960).

The absolute abundances of the isotopes of fission-product xenon and krypton in six uranium minerals have been determined mass spectrometrically using the isotope dilution technique. The fission products were resolved into a U^{238} spontaneous fission component, a U^{235} neutron-induced fission component, and a U^{238} neutron-induced fission component. Internal consistency in the analysis was achieved only when the Xe^{129} yield used for the U^{235} thermal neutron fission component was 20% lower than that reported by Purkayastha and Martin at I^{129}. This discrepancy in the mass 129 chain yield measured at I^{129} and at Xe^{129} has not been resolved. Only one of the six minerals, Cinch Lake pitchblende, retained essentially all of its fission product inert gases throughout geological time. Inert gas losses from the remaining five minerals ranged from 20% to 75%. The absolute yields of the stable xenon and krypton fission products in U^{238} spontaneous fission were determined from an analysis of the inert gases from Cinch Lake mineral. This analysis showed that 95.9% of the fission gas in this case resulted from the spontaneous fission and only 4.1% from neutron-induced fission.

NUCLEAR POWER STUDIES

539.17

2697 NON-DESTRUCTIVE TESTING OF SOLID FUEL ELEMENTS. G.Perona.
Energia nucleare, Vol. 6, No. 10, 621-7 (Oct., 1959). In Italian.

Testing of fuel elements and their components during consecutive working steps and after their finishing is described. Some of the methods employed have been purposely set up, others have been conveniently modified compared with these traditionally used for non-destructuve testing of ordinary machined pieces.

539.17

2698 A CRITICAL SURVEY OF THE LITERATURE ON BURNOUT STUDIES WITH WET STEAM.
A.Cicchitti, M.Silvestri, G.Soldaini and R.Zavattarelli.
Energia nucleare, Vol. 6, No. 10, 637-60 (Oct., 1959).

The experimental data and the studies on the burnout phenomenon with steam-water mixture are considered. A new correlation of burnout heat flux data is proposed and a comparison between the existing correlations and the proposed correlation is made. Burnout heat flux data obtained with the experimental facility CISE-Edisonvolta are reported.

539.17

2699 A PRECAUTIONARY CALCULATION OF THE REACTOR START-UP INCIDENT. A.Ascari.
Energia nucleare, Vol. 6, No. 11, 702-6 (Nov., 1959). In Italian.

A consistent account is given of the theory of the start-up incident, leading to the result known as "Newson's inequality". The treatment is completed with some less known results on the height of the power excursion and the amount of the energy release in the incident.

539.17

2700 THE FIRST START-UP OF THE SORIN "AVOGADRO RSI" REACTOR. A.Ascari, G.Horn and E.Pedretti.
Energia nucleare, Vol. 6, No. 12, 753-62 (Dec., 1959). In Italian.

This article is an account of the preparation to the start-up of the Sorin "Avogadro RSI" reactor. The check of the control instrumentation and the training of the staff are particularly dealt with. A short description of the main start-up equipment and a concise report on the first critical experiment are also given.

539.17

2701 ON WELTON'S STABILITY CRITERION FOR NUCLEAR REACTORS. H.B.Smets.
J. appl. Phys. Vol. 30, No. 10, 1623 (Oct., 1959).

A simple proof is given of Welton's criterion [Proceedings of the International Conference on the Peaceful Uses of Atomic Energy 1955, New York: United Nations (1956), Vol. 5, p.377.] for step changes of reactivity, starting from the classical reactor kinetics equation. It is also shown that, for the same assumed conditions, any small change in one of the parameters will not lead to unstable behaviour. A similar proof leads to the same conclusions for the case of negative zero-power reactivity. A.J.Salmon

539.17

2702 DETERMINATION OF THE RELATIVE U^{235}-Pu^{239} CONVERSION FACTORS IN LATTICES OF NATURAL URANIUM AND ORDINARY WATER.
L.V.Komissarov and V.A.Tarabanko.
J. nuclear Energy, Vol. 4, No. 1, 122-7 (Jan., 1957). English translation of article in: Atomnaya Energiya, Vol. 1, No. 3, 56 (1956).

The ratios of the initial conversion factors for various uranium-water lattices to the conversion factor in a uranium-graphite lattice have been measured. The results show that in uranium-water lattices if the pitch indicated, the breeding coefficient of plutonium is greater than in a uranium-graphite lattice.

539.17

2703 THE ACTIVATION OF FLOWING, LIGHT SUBSTANCES IN A SPACE DEPENDENT NEUTRON FIELD.
W.Hage and R.Nicks.
Atomkernenergie, Vol. 4, No. 5, 181-5 (May, 1959). In German.

The specific activity of a fluid circulating with constant velocity through a reactor is calculated as a function of position in the reactor and the number of times it has passed around the loop. Various simple cases are dealt with: a single transit of the reactor per turn, a double transit per turn, n transits per turn, reactors with uniform flux and cosine neutron distribution. D.H.Lord

539.17

2704 THE γ-RAY SPECTRUM FROM THE I.R.T. REACTOR. L.V.Groshev and A.M.Demidov.
Atomnaya Energiya, Vol. 7, No. 3, 257-8 (Sept., 1959). In Russian.

Gives the corrected spectrum of γ-rays from the core of this reactor, measured with a magnetic Compton spectrometer. J.B.Sykes

539.17 : 518.5

ANALOGUE COMPUTERS AND NUCLEAR PLANTS.
See Abstr. 2068

ATOMS

539.18

2705 POLARIZABILITIES AND ANTISHIELDING FACTORS OF 10 AND 18 ELECTRON CLOSED SHELL ATOMS.
G.Burns.
J. chem. Phys., Vol. 31, No. 5, 1253-5 (Nov., 1959).

Polarizabilities and antishielding factors are obtained for a number of ions that have ten and eighteen closed shell electron configurations. Certain empirical relationships are found so that other polarizabilities and antishielding factors can be deduced. The results using Hartree and Hartree Fock wave-functions are also compared.

539.18

2706 INITIAL ESTIMATES FOR SELF-CONSISTENT FIELD CALCULATIONS FOR ATOMS WITH LARGE ATOMIC NUMBER. C.Froese.
Phys. Rev., Vol. 116, No. 4, 900-2 (Nov. 15, 1959).

Absolute rather than interpolation methods are described for obtaining initial estimates for self-consistent field calculations with exchange. Tables have been computed so that the procedure is entirely numerical which makes it more convenient than Hartree's graphic interpolation scheme.

539.18

2707 PLUVINAGE METHOD FOR SYSTEMS OF THREE CHARGED PARTICLES. L.Spruch and M.Kelly.
Phys. Rev., Vol. 116, No. 4, 911-13 (Nov. 15, 1959).

A method due to Pluvinage (Abstr. 7750 of 1950) for finding ground-state energies of two-electron systems has been studied. His choice of a trial function, Ψ_K, is of interest since $H\Psi_K$, where H is the Hamiltonian, is free of singularities. However, his calculations had to be done numerically. It has been found possible to utilize the method in such a way that, with little loss in accuracy, the various calculations can be performed analytically. With a trial function which contains no variational parameters, the method just fails to give a bound state for H^-. (The results for Z greater than unity are quite accurate). The introduction of a scaling factor gives a bound state. Thus, only one variational parameter is required to prove the existence of a bound state, as compared with the two parameters required for a Hylleraas-type trial function. However, the calculations are much more tedious. The method has been generalized to be applicable to an arbitrary system of three charged particles which interact only through their Coulomb fields. It has been applied to the proton, proton, μ^- system, but it does not give very useful results there.

539.18

2708 FOCK'S CYCLIC SYMMETRY CONDITION AND YOUNG'S PATTERNS. G.I.Zel'tser.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1058-9 (Oct., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 4, 738-9 (April, 1959).

It is shown that a function symmetrized according to a general Young pattern has the A-normal form of Hund. The fact that Fock's condition (in derivation of a wave-function for an n-electron system) is satisfied for Young patterns with two columns is an important specia special case of this result. T.R.Carson

539.18

2709 ENERGY LEVELS OF P XII.
A.M.Naqvi.
Proc. Nat. Inst. Sci. India A, Vol.21, No.4, 238-40 (July 26, 1955).

The energies of the three 3P levels of the configuration $1s^2 2s2p$ of P XII have been calculated by two different methods of extrapolation along the isoelectronic sequence, which gives results in good agreement with one another.

539.18 : 535.33 : 539.2

ENERGY LEVELS OF URANIUM V. See Abstr. 1731

539.18

2710 ANALYTIC 3d WAVE-FUNCTIONS FOR ATOMS OF THE IRON GROUP FOR SMALL AND LARGE DISTANCES FROM THE NUCLEI. C.Caviglia and I.Fidone.
Nuovo Cimento, Vol. 14, No. 3, 649-42 (Nov. 1, 1959).

Presents a three-exponential approximation to Worsley's Hartree–Fock 3d wave-function for V^{++} (Abstr. 467 of 1960). Corresponding functions for Z = 22 to Z = 29 are deduced by scaling, with a scaling number which depends on the use for which the wave-function is intended. Agreement with experiment is encouraging. J.Hawgood

539.18

2711 TRIPLET INTERVALS OF HELIUM.
G.Araki, M.Ohta and K.Mano.
Phys. Rev., Vol. 116, No. 3, 651-3 (Nov. 1, 1959).

The triplet intervals of the deepest P-state of helium are calculated by making use of the wave-function recently determined by the present authors [Progr. theor. Phys., Vol. 22, 469 (1959)]. The polarization of the s-orbital, the admixture of the singlet, and the quantum-electrodynamic fourth-order correction are all taken into account. The theoretical values of the intervals are $^3P_0$-$^3P_1$ = $= 997\,457\,11 \times 10^{-3}\,cm^{-1}$ and $^3P_1$-$^3P_2$ = $75.974\,45 \times 10^{-3}\,cm^{-1}$.

539.18

2712 HYPERFINE STRUCTURE OF THE METASTABLE TRIPLET STATE OF HELIUM THREE.
J.A.White, L.Y.Chow, C.Drake and V.W.Hughes.

Phys. Rev. Letters, Vol. 3, No. 9, 428-9 (Nov. 1, 1959).

The frequency difference at zero magnetic field between the levels (3/2, −1/2) and (1/2, −1/2) of the state ($1s2s$, $^3S_1$) was measured by the atomic beam magnetic resonance method, which gave $\Delta\nu = 6739.7013 \pm 0.0004$ Mc/s. Comparison between theory and experiment for the ratio of this value to that for the $^3S_{1/2}$ state of the He^{3+} ion (Abstr. 1802 of 1959) gave a larger discrepancy than expected: this is attributed to inaccuracy in the computation of the relativistic correction for the atom. J.Hawgood

539.18

2713 VARIATIONAL CALCULATIONS OF ENERGY AND FINE STRUCTURE FOR THE 2^3P STATE OF HELIUM. J.Traub and H.M.Foley.
Phys. Rev., Vol. 116, No. 4, 914-19 (Nov. 15, 1959).

Using an 18-parameter Hylleraas-type wave-function containing only positive powers, a calculation has been carried out for the 2^3P state of helium by the Ritz variational principle. Breit's reduction was used to convert the problem from six to three variables. The energy was minimized by the approximate solution of an eigenvalue problem. With this wave-function the fine structure splitting was calculated. The best wave-function yields an energy 15.5 cm^{-1} above the experimental value while the corresponding fine structure splitting is in error by about 1 part in 10^3. All computation was carried out on an IBM-650 computer.

539.18

2714 RELATIVE MEASUREMENT OF THE PHOTODETACHMENT CROSS SECTION FOR H^-. S.J.Smith and D.S.Burch.
Phys. Rev., Vol. 116, No. 5, 1125-31 (Dec. 1, 1959).

The spectral dependence of the photodetachment cross-section was measured in the range from 4000 to 13 000 A with approximately 300 A resolution. Measurements were made with twenty-five band pass filters, each measurement taken relative to the value obtained with a control filter at 5280 A. A probable error of about 2% is attached to the relative value obtained for each filter. The results are in significant disagreement with available calculated cross-sections (e.g. Abstr. 6350 of 1958).

539.18

2715 MAGNETIC DIPOLE RESONANCE OF EXCITED LEVELS IN FREE IONS OF Cd II AND Zn II. E.Geneux and B.Wanders-Vincenz.
Phys. Rev. Letters, Vol. 3, No. 9, 422-3 (Nov. 1, 1959).

Using the Kastler–Brossel type experiment with electron impact excitation, the authors have observed the magnetic dipole resonance of the 4416 A Cd II line and of the 5894 A Zn II line by measuring polarization difference $I_\pi - I_\sigma$ as a function of the steady magnetic field. The lifetimes of the $^2D_{3/2}$ state of Cd II, the $^2D_{3/2}$ state of Zn II and the polarization percentage of the 5894 A line of Zn II were determined. The optimum population ratio of the $^2D_{3/2}$ level Zeeman sublevels for 8% polarization is deduced to be 0.805. Graphs are given of the percentage polarization and excitation function of the 5894 A line of Zn II against electron energy. J.S.Young

539.18

2716 COLLISIONS OF AN ELECTRON WITH A HYDROGEN ATOM. M.Morand, M.C.L.Le Gentil and S.Desprez-Rebaud.
C.R. Acad. Sci. (Paris), Vol. 249, No. 20, 2060-1 (Nov. 16, 1959). In French.

Presents results of calculations of the effective differential cross-section for ejection of an electron with various energies from an H atom by collision with an electron incident at 1000 eV or at 50 000 eV. The results are obtained both classically and quantally (with Born approximation). J.Hawgood

539.18

2717 CROSS SECTIONS FOR THE EXCITATION OF THE METASTABLE 2s STATE OF ATOMIC HYDROGEN BY ELECTRON COLLISION. W.Lichten and S.Schultz.
Phys. Rev., Vol. 116, No. 5, 1132-9 (Dec. 1, 1959).

The function for excitation of the 2s state of atomic hydrogen by electron impact was measured from threshold to 45 eV by an atomic beam method. The absolute value of the total cross-section was determined by two independent methods which are in agreement. In one method the excitation function was normalized to the Born approximation at the higher energies. The mechanism of cascade from higher p states was found to play a significant role in population of the metastable 2s level. The other method proceeded by determining the metastable detection efficiency in terms of the known efficiency for Lyman-α photons. The yield for ejection of electrons from an untreated platinum surface by H(2s) is 0.065 ± 0.025. The total cross-section reaches a maximum value of $(0.35 \pm 0.05)\pi a_0^2$ at 11.7 eV. The exchange cross-section was also measured by the atomic beam method. The incident atoms were polarized in a Stern–Gerlach experiment; the metastable atoms were analysed by the selective quenching action of a magnetic field of 575 G. The ratio of the exchange to total cross-section is 0.45 ± 0.05 near threshold. At higher energies, this ratio approaches zero. The cross-section for production of metastable atoms by direct bombardment of molecular hydrogen is $0.03\pi a_0^2$. This value is considered correct to within a factor of two.

539.18 : 539.12

2718 ANGULAR CORRELATION OF CIRCULARLY POLARIZED GAMMA-QUANTA FROM A μ-MESIC ATOM. V.A.Dzhrbashyan.
Zh. eksper. teor. fiz. Vol. 35, No. 1(7), 307-8 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 8(35), No. 1, 212-3, (Jan., 1959).

A formula is given for the angular distribution and correlation of gamma-rays from the 2s–2p–1s cascade transition of a μ-mesic atom, assuming zero-spin nucleus. This distribution can be used to determine the degree and direction of polarization of the μ-meson before its capture by the atom. D.W.L.Sprung

539.18

2719 LEVEL WIDTHS OF π-MESIC ATOMS. A.I.Lebedev.
Zh. eksper. teor. fiz., Vol. 35, No. 4(10), 1045-7 (Oct., 1959). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 729-30 (April, 1959).

By considering the interaction between slow π^--mesons and nuclei as a perturbation of the Coulomb potential of a point source, and taking into account a measured value of the s-state energy level width, the imaginary part of the potential of the meson–nucleus interaction is estimated to be about 1.5 MeV. Experimental indications of the relative probabilities of nuclear capture and decay for stopping pions are discussed. J.D.Dowell

539.18 : 539.12

THE π-MESONIC ATOM AND CORRECTIONS TO THE DISPERSION RELATIONS. See Abstr. 2583

539.18

2720 GENERALIZED ATOMIC MASS LAW. F.S.Mozer.
Phys. Rev., Vol. 116, No. 4, 970-5 (Nov. 15, 1959).

Least-squares analyses have been performed on a set of atomic masses using standard and generalized semiempirical mass laws. Presumably because of errors in the assumed form of the standard mass law, its least-squares coefficients can be determined at best to an accuracy of about 10%, and masses are predicted with an uncertainty of several MeV/c^2. The standard mass law has been generalized by addition of shell effect and deformation terms. While the least-squares fitting of the generalized mass law is better than for the standard mass law, it is still not possible to predict atomic masses to an accuracy better than a few MeV/c^2. The nuclear deformations and the well depths of the nuclear interaction obtained from the additional mass-law terms are in reasonable agreement with more accurate determinations by other methods. A similar statement applies to the nuclear radius constant as obtained from the least-squares coefficient of the Coulomb energy term. A study has also been made of the effects of additional terms proportional to the absolute value of the isotopic spin, exchange and surface corrections to the Coulomb energy, and the surface correction to the normal isotopic term.

539.18

2721 A PRELIMINARY APPROACH TO THE CALCULATION OF A WATER-HYDROGEN SULPHIDE DUAL TEMPERATURE DEUTERIUM SEPARATING PLANT. B.Brigoli and S.Villani.
Energia nucleare, Vol. 6, No. 12, 784-92 (Dec., 1959).

An attempt to solve some calculation problems connected with the design of a water-hydrogen sulphide dual temperature deuterium separating plant. The elementary separation factor and the single-stage enrichment factor have been calculated. The optimal enrichments have been derived both for a single stage and a two-stage

plant with respect to column volumes. Furthermore, the application of climbing film type heat exchangers for heat recovery in the gas line has been considered.

539.18

2722 THE PRODUCTION OF H ATOMIC BEAMS WITH UNIDIRECTIONAL NUCLEAR SPINS. ANALYSIS OF THE BEAMS, PROOF OF MAINTENANCE OF POLARIZATION. G.Clausnitzer.
Z. Phys., Vol. 153, No. 5, 609-29 (1959). In German.

The apparatus, consisting basically of two four-pole magnetic fields, and the method of detection of the beams are described. The determination of the degree of polarization is discussed in detail; also the influence of residual gas ions, magnetic field measurements and the number density of the beams. H.C.Cole

539.18 : 537.534

2723 SMALL-ANGLE SCATTERING IN COLLISIONS BETWEEN NEUTRAL ATOMS. H.Pauly.
Z. Phys., Vol. 157, No. 1, 54-64 (1959). In German.

For the scattering of atomic alkali beams by mercury atoms the angular distribution of the scattered intensity at small angles has been investigated. The results confirm earlier theoretical estimations, by which the total collision cross-section and the differential cross-section at small angles for the colliding particles used in these experiments should be almost entirely determined by the van der Waals forces. The measured angular distribution can be calculated down to angles of a few minutes of arc by means of classical mechanics. For deviations at smaller angles a quantum mechanical approximation can be given. Moreover, the results allow the determination of the total collision cross-section as a function of the angular resolution of the apparatus. Hereby information can be obtained about the critical angle, smaller than which the angular resolution in an atomic beam experiment has to be in order to measure the right value of the total cross-section.

539.18

2724 SCATTERING OF ELECTRONS BY NEUTRAL ATOMS. B.A.Lippmann, H.Mittleman and K.M.Watson.
Phys. Rev., Vol. 116, No. 4, 920-5 (Nov. 15, 1959).

A recent reformulation (Abstr. 5106 of 1959) of the theory of electron scattering by atoms—in which those scatterings, real or virtual, that leave the state of the atom unchanged are separated off from the remainder—has been generalized to include the effects of the Pauli principle. The case where the Hartree approximation suffices to describe the atom is considered in detail, including a calculation of the "scattering potential" to second order.

539.18

2725 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS BY ARGON. B.Kivel.
Phys. Rev. Vol. 116, No. 4, 926-7 (Nov. 15, 1959).

The partial-wave Schrödinger equation has been integrated numerically for a potential adjusted so that the predicted elastic scattering is in agreement with measurements by Ramsauer and Kollath (Abstr. 1323 of 1930). The cross-section at zero energy is found to be 8×10^{-16} cm^2 which is appreciably above the minimum value of 0.3×10^{-16} cm^2 at 0.4 eV. The high value at zero energy, which results from the tail of the polarization force, will be reduced at densities of 1 atm. and above, because the field is cut off by neighbouring atoms. Application of the method to predict the eigenvalues of the excited bound states of potassium indicates the validity of the static potential and that the exchange force decreases with increasing angular momentum.

539.18

2726 ELECTRON SCATTERING BY NOBLE GASES IN THE LIMIT OF ZERO ENERGY. B.Kivel.
Phys. Rev., Vol.116, No.6, 1484-5 (Dec. 15, 1959).

The elastic scattering at zero energy by argon depends strongly on the polarization tail (see preceding abstract), since the contribution to the scattering length by forces inside the atom cancel. Assuming this is true for all noble gases, one can approximate their zero-energy elastic cross-section by $3.52 \times 10^{-16}(p/r_0)^{\frac{2}{3}}$ cm^2, where both p, the polarizability, and r_0, the size of the atom, are in atomic units. Using published values of the polarizability and scaling r_0 as the cube root of the atomic number from $r_0 = 8$ for argon, it is found that this expression is consistent with existing experimental data. It is conjectured that the success of this approximation is a result of the Pauli exclusion principle.

539.18

2727 REACTIONS OF METASTABLE ATOMS AND RESONANCE PHOTONS. J.B.Hasted and P.Mahadevan.
Proc. Roy. Soc. A, Vol. 249, 42-50 (Jan. 1, 1959).

Collision experiments with He $2\,^3S$ and Ne ^3P metastable atoms are described, giving the total collision cross-sections of these atoms and their resonance photons with He, Ne, A at thermal energies. Their values are discussed in terms of energy considerations. The secondary electron yields from He metastable atoms incident upon W, Mo, Pt surface flashed to 1700°C are compared with the yield from an unflashed Au surface, which is known absolutely from the experiments of Stebbings. The gas contamination of the surface causes the yields to rise. The absolute yields from atomically clean surfaces are calculated and compared with the data of Hagstrum for positive ions. The yields for the resonance photons have also been determined, and are compared with the data of various workers.

539.18

2728 USE OF PARAMAGNETIC-RESONANCE TECHNIQUES IN THE STUDY OF ATOMIC OXYGEN RECOMBINATIONS. S.Krongelb and M.W.P.Strandberg.
J. chem. Phys., Vol. 31, No. 5, 1196-210 (Nov., 1959).

A method for making measurements of atomic recombination times with the use of a paramagnetic-resonance spectrometer and its advantages are described. The theory of the paramagnetic-resonance spectrometer applied to these measurements is presented. Methods for using both diffusion and flow systems for determining surface and volume recombination coefficients are analysed. The operation of the system that was used is illustrated for atomic oxygen recombination. The surface recombination coefficient for oxygen atoms on a quartz surface is shown to be 3.2×10^{-4} per collision, and the second-order volume recombination coefficient was less accurately determined as 5×10^{15} cm^6 mole^{-2} sec^{-1}. The measurement of the diffusion coefficient of atomic oxygen is described. The possible application of these methods to further study of reaction rates is discussed.

539.18

2729 EFFECT OF SIMULTANEOUS DOPPLER AND COLLISION BROADENING AND OF HYPERFINE STRUCTURE ON THE IMPRISONMENT OF RESONANCE RADIATION. P.J.Walsh.
Phys. Rev., Vol. 116, No. 3, 511-15 (Nov. 1, 1959).

For previous work, see Abstr. 563 (1958). The transmission coefficient defined by Holstein (Abstr. 9387 of 1951) for resonance radiation has been calculated when Doppler and collision broadening of the resonance line are present simultaneously. From this a simple formula is inferred for the imprisonment lifetime of the resonance radiation under this condition. The complication of the hyperfine structure is also taken into account and the results are found to give good agreement with experiments in mercury.

539.18

2730 EFFECT OF E.M. RADIATION ON LAMB SHIFT. II. I.Singh.
Proc. Nat. Inst. Sci. India A, Vol. 21, No. 4, 280-9 (July 26, 1955).

For Pt I,see Abstr. 2403 (1955). The effect of interaction with the electromagnetic field in modifying the spectral terms of a Dirac electron in an external field of force is investigated, using the conventional form of perturbation theory. The magnitude of the shift is evaluated numerically. It is shown that this displacement of the energy levels differs in many respects from the Lamb shift, which is due to the effect of the scalar radiation field as it exists in the vacuum.

539.18

2731 ON THE LAMB SHIFT AND OTHER RADIATIVE EFFECTS. III. I.Singh.
Proc. Nat. Inst. Sci. India A, Vol. 21, No. 5, 291-301 (Sept. 26, 1955).

The influence of radiative forces on several processes, involving the interaction between a charged particle and a fixed potential, is investigated. The effect of fields as they exist in the vacuum, as well as external fields,is considered.

539.18

2732 NOVEL METHOD OF SPECTROSCOPY WITH APPLICATIONS TO PRECISION FINE STRUCTURE MEASUREMENTS.
F.D.Colegrove, P.A.Franken, R.R.Lewis and R.H.Sands.
Phys. Rev. Letters, Vol.3, No.9, 420-2 (Nov. 1, 1959).

Describes a new method of spectroscopy which can give precise measurements of some atomic fine structure intervals. The technique uses the interference phenomena which can occur in the resonance fluorescence of an atom in which two of the excited Zeeman substates cross. The method is described with reference to the helium 2^3_1-2^3P_2 separation. A brief description of the apparatus is given and the method of interpreting the results is indicated. For the above mentioned separation the authors find that $^3P_1 - {}^3P_2$ = 2291.56 ± 0.09 Mc/s. J.S.Young

539.18 : 539.14

2733 NUCLEAR ISOMERISM AND ATOMIC SPECTRA. R.Wainer.

Zh. eksper. teor. Fiz., Vol.35, No.1(7), 284-6 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol.35(8), No.1, 196-7 (Jan., 1959).

Discusses the effect of nuclear isomerism on the shift of atomic spectra of all odd nuclei under the basic assumptions that all nuclear transitions are single-particle transitions in accordance with the shell model, and that the shift is due to the Coulomb interaction in nuclei with optical protons. In nuclei with optical neutrons the effect is assumed to be connected with the neutron–electron interaction. S.J.St-Lorant

539.18 : 539.19

RESONANCE LINES OF K, Rb, Tl, Cs AND Hg. See Abstr. 1533

539.18 : 535.33

2734 NEW WAVELENGTHS FOR SOME HELIUM (He I) LINES. W.C.Martin.

J. Opt. Soc. Amer., Vol. 50, No. 2, 174-6 (Feb., 1960).

New vacuum wavelengths for nine lines of He I in the near ultraviolet and visible regions are given. They were obtained by measurement relative to 5462.2707 A and 4359.5625 A of Hg^{198} I with an evacuated Fabry–Perot interferometer. Liquid-nitrogen cooled helium lamps were used. Interference fringes were obtained for the helium line 5017 A with spacers up to 50 mm in length. The wavelength of this line, which was used as a reference wavelength in some previous work on the Rydberg constant, is found to be 5017.0772 ± 0.0003 A (vac.) relative to the stated values for the two standards.

539.18 : 539.12

ATOMIC PHOTOELECTRIC EFFECT AND BREMSSTRAHLUNG AS INVERSE PROCESSES. See Abstr. 2513

MOLECULES

539.19

2735 DISSOCIATION ENERGY OF S_2. L.Brewer.

J. chem. Phys., Vol. 31, No. 4, 1143-4 [Oct., 1959].

The recent revision of the analysis of the ultraviolet system of SO by Norrish and Oldershaw, in which v" is raised by two units, leads to a higher D(SO) and to $D(S_2)$ = 4.4 eV. Recent literature is reviewed. The new value is supported by a comparison with other molecules of the first and second row of the periodic table. A.G.Gaydon

539.19

2736 DISSOCIATION ENERGIES OF SO AND S_2. D.G.H.Marsden.

J. chem. Phys., Vol. 31, No. 4, 1144-5 (Oct., 1959).

Combination of Norrish and Oldershaw's revised value for D(SO) with Dewing and Richardson's thermochemical data give $D(S_2)$ = 4.4 eV. This leads to D(SO - O) = 131 kcal. Some other data support this, but electron impact and vapour density measurements are inconsistent with it; the value for $D(S_2)$ is still doubtful. A.G.Gaydon

539.19

2737 KLEIN–DUNHAM POTENTIAL ENERGY FUNCTIONS IN SIMPLIFIED ANALYTICAL FORM. W.R.Jarmain.

Canad. J. Phys., Vol. 38, No. 2, 217-30 (Feb., 1960).

A simple formula, based originally on the work of Klein and Rees, is developed for calculating potential energy curves, except near the dissociation limit, for electronic states of diatomic molecules. Classical turning points are given as functions of vibrational quantum number, with coefficients depending on observed spectroscopic constants. For most states convergence is rapid, but as a rule more so for heavy molecules than for light molecules. Assuming it to be close to the "true" potential, the representation affords a convenient means of assessing the accuracy of the Morse or other empirical potential function. Morse curves have also been fitted by least squares to Klein–Rees turning points. Term-by-term comparison between the inverted Dunham series and an equivalent form of that derived has led to the surprising discovery that if Dunham's small correction terms are neglected, Klein and Dunham potentials are mathematically identical. This is contrary to the generally held belief that the two should be used in mutually exclusive regions. In the present form these series exhibit better behaviour over a wider range than a series giving potential energy as a function of internuclear separation.

539.19

2738 THE IONIC CHARACTER OF SINGLY BONDED MOLECULES. P.Venkateswarlu and T.S.Jaseja.

Proc. Indian Acad. Sci. A, Vol. 44, No. 2, 72-82 (Aug., 1956).

The overlap factors for bond electrons in various diatomic halides are calculated making use of a simple relation where the overlap factor is an inverse exponential function of the difference between the two atomic radii of the molecule concerned. These overlap factors together with the hybridization values of 15% for Cl, and 10% for Br and I are used to calculate the ionic characters for various diatomic molecules from the values of the nuclear quadrupole coupling constants obtained by earlier workers. These ionic characters are then plotted against electronegativity differences and the points are found to be fairly well represented by a smooth curve. It is shown that this curve can in general be used for the determination of the ionic characters in the halogen containing single bonds of certain polyatomic molecules. The quadrupole coupling constants are calculated from the ionic characters obtained from the curve and are compared with those observed. The effects of the distortion of the closed shells and of the neighbouring ions on eQq are discussed.

539.19

EVIDENCE FOR A LOW-LYING SECOND POTENTIAL MINIMUM IN HYDROGEN-BONDED SYSTEMS. C.L.Bell and G.M.Barrow.

J. chem. Phys., Vol. 31, No. 5, 1158-63 (Nov., 1959).

The spectra of phenol-d and p-nitrophenol-d associated with amines in chloroform show, in the region of the stretching fundamental, a band splitting that can be interpreted in terms of a double minimum potential for the proton. For p-nitrophenol and a base as strong as triethylamine, both the infrared and visible spectra show that the associated complex consists of a tautomeric equilibrium between proton transferred and nonproton transferred species. For these systems also, the potential experienced by the proton shows a double minimum. It appears, therefore, that for hydrogen-bonded systems of the type dealt with here in nondissociating solvents the hydrogen-bonding proton will experience a double minimum potential for all strengths of association.

539.19

2740 COMPUTATION OF ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS. III. FIRST-ORDER CENTRIFUGAL STRETCHING EFFECTS. P.M.Parker and L.C.Brown.

J. chem. Phys., Vol. 31, No. 5, 1227-30 (Nov., 1959).

For Pt II, see Abstr. 7427 (1959). Further expressions are developed which relate the parameters of the asymmetric rotator to experimental data through moments of the energy levels. The expressions developed apply to an asymmetric rotator system described by a Hamiltonian which includes terms allowing for first-order centrifugal stretching effects. A criterion for the applicability of the first-order theory is given.

539.19

2741 LINE SHAPE AND *f* VALUE IN THE OH $^2\Sigma^+ - {}^2\Pi$ TRANSITION. T.Carrington.

J. chem. Phys., Vol. 31, No. 5, 1243-52 (Nov., 1959).

Line shape and f value in the ultraviolet transition $^2\Sigma^+ - {}^2\Pi$ of OH were studied by the curve of growth method, and rough direct measurements of line width have been made. The lines $Q_1 6$, $P_1 6$, $R_1 6$, $Q_{21} 6$, and $S_1 6$ fit a curve of growth indicating a collision broadening width of 0.02 ± 0.02 cm^{-1} at 2600°K and 1 atm in flame gases

of the approximate composition O_2 60%, H_2O 20%, and CO_2 20%. For the $Q_1 6$ line, the f value is $(11.7 \pm 4) \times 10^{-4}$. This corresponds to a radiative lifetime for the free molecule of 5.5×10^{-7} sec, in excellent agreement with the earlier work of Oldenberg. Brief discussions are given of theoretical limitations on the use of the curve of growth, and of the qualitative factors to be considered in explaining the observed line-width.

539.19

2742 ANGULAR DEPENDENCE OF ELECTRON-COUPLED PROTON INTERACTIONS IN CH_2 GROUPS.

H.S.Gutowsky, M.Karplus and D.M.Grant.
J. chem. Phys., Vol. 31, No. 5, 1278-89 (Nov., 1959).

Experimental and theoretical studies have been made of the dependence upon HCH angle of the electron-coupled proton-proton interactions in CH_2 groups. A valence-bond approximation is used in the theoretical treatment which predicts that the coupling constant A_{gem}^{HH} decreases from 32 c/s to 0 c/s for HCH angles of 100° to 125°. For angles greater than 125°, A_{gem}^{HH} is predicted to be negative. Experimental values of A_{gem}^{HH} have been obtained from analyses of the proton magnetic-resonance spectra of a number of compounds, including several partially deuterated species. Insofar as the HCH angles are known in these compounds, there is good agreement between the theoretical and experimental coupling constants, especially for angles smaller than 120°, for which A_{gem}^{HH} changes more rapidly with angle. Moreover, a negative value is found experimentally for A_{gem}^{HH} in vinyl bromide at an HCH angle which is approximately that at which the theory predicts the coupling to become negative. The substituted ethylenes constitute the largest group of compounds studied experimentally. In them, A_{gem}^{HH} has been found to vary from 3.2 c/s to −1.8 c/s, while the A_{cis}^{HH} values range from 6.9 c/s to 12 c/s and the A_{trans}^{HH} from 14.3 c/s to 18.4 c/s. The various results presented indicate that the value of the coupling constant can serve as a measure of the HCH angle. However, further work is needed to confirm the reliability of the method and investigate the effect of substituent perturbations.

539.19

2743 SIGN OF THE ELECTRON SPIN DENSITY ON METHYL PROTONS IN AROMATIC MOLECULES.

A.Forman, J.N.Murrell and L.E.Orgel.
J. chem. Phys., Vol. 31, No. 4, 1129 (Oct., 1959).

Experimental results on the n.m.r. spectra of acetylacetonates confirm the theoretical prediction that in a conjugated free radical containing a C-CH_3 group, the electron spin density on the methyl protons has the same sign as that in the carbon π-orbital.

W.J.Orville-Thomas

539.19

2744 SECOND-ORDER QUADRUPOLE EFFECT IN THE MICROWAVE SPECTRUM OF PROPARGYL BROMIDE.

Y.Kikuchi, E.Hirota and Y.Morino.
J. chem. Phys., Vol.31, No.4, 1139-40 (Oct., 1959).

First-order theory does not suffice to explain the nuclear quadrupole hyperfine structure of b-type transitions of propargyl bromide, $HC \equiv CCH_2Br$. The experimental data can be explained on the basis of second-order theory and a value of $\chi_{zz} = 587$ Mc/s determined explicitly. This may be compared with a value of 577.15 Mc/s found for methyl bromide. W.J.Orville-Thomas

539.19

2745 PROTON NUCLEAR MAGNETIC SHIELDING AND THE DIAMAGNETIC ANISOTROPY OF C−C AND C−H BONDS IN PROPANE. P.T.Narasimhan and M.T.Rogers.
J. chem. Phys., Vol. 31, No. 5, 1302-6 (Nov., 1959).

The nuclear magnetic resonance shielding σ of a proton in a molecule can be written as the sum of two contributions, namely, (a) the local or primary shielding σ_l due to the surrounding electron cloud, and (b) the distant or secondary shielding σ_d due to magnetically anisotropic charge distributions farther away from the nucleus. An internal chemical shift Δσ between two protons A and B may originate from differences in σ_l and/or σ_d ($\Delta\sigma_l$ and $\Delta\sigma_d$, respectively). Using the hindered-rotation model for propane (A_2B_2) an expression for $\Delta\sigma_d$ between the methyl and methylene group protons has been derived in terms of the magnetic anisotropy ($\Delta\chi$) of the C−H and C−C bonds in this molecule. If it is assumed that σ_l for both methyl and methylene group protons is the same, the internal chemical shift can be expressed solely in terms of the bond anisotropies. The value of the ratio $\Delta\chi^{CC}/\Delta\chi^{CH}$ of the bond anisotropies thus obtained using the experimental value of Δσ is much larger than the theoretical value of $\Delta\chi^{CC}/\Delta\chi^{CH}$ obtained by Tillieu. To the extent then that the theoretical studies of Tillieu on bond susceptibilities may be relied on, the calculations would indicate that there is a difference between the local shielding σ_l of the methyl and methylene group protons in propane. Since this difference in local shielding values may logically be related to an electronegativity difference between the CH_2 and CH_3 groups, $\Delta\sigma_l$ is evaluated empirically from a modified form of the Dailey–Shoolery equation. Using this value along with the observed Δσ an estimate of $\Delta\sigma_d$ was obtained which then led by the method to a value of $\Delta\chi^{CC}/\Delta\chi^{CH}$ which is in reasonable agreement with the theoretical results of Tillieu. A semi-quantitative treatment for $\Delta\sigma_l$ using theoretically calculated "atom charges" of methyl and methylene group protons also yields a value $\Delta\chi^{CC}/\Delta\chi^{CH}$ in satisfactory agreement with the theoretical value for this quantity. The results may therefore be taken to indicate that both the local and distant shielding terms contribute to the total internal chemical shift in propane and that the former term is probably the more important.

539.19

2746 HYPERFINE INTERACTION AND QUADRUPOLE COUPLING CONSTANT IN THE HYDROGEN MOLECULE ION. M.J.Stephen and J.P.Auffray.
J. chem. Phys., Vol. 31, No. 5, 1329-32 (Nov., 1959).

An accurate calculation has been made of the interaction between the electron spin magnetic moment and a nuclear moment for the ground state of the hydrogen molecule ion. An accurate value of the electric field gradient at the nucleus was also obtained. The values are compared with values from an approximate LCAO wave-function. The possibility of observing the paramagnetic resonance spectrum of this molecule is discussed.

539.19

2747 PARAMAGNETIC RESONANCE IN THE FREE HYDROXYL RADICAL. H.E.Radford.
Nuovo Cimento, Vol. 14, No. 1, 245-7 (Oct. 1, 1959).

Three well-defined groups of lines have been detected in the paramagnetic resonance spectrum of the free OH radical. Two have been assigned to transitions in the $\pi_{3/2}$, J = 3/2 level and the third to the $\pi_{3/2}$, j = 7/2 level. W.J.Orville-Thomas

539.19

2748 HÜCKEL THEORY: AN EFFECTIVE HAMILTONIAN. W.D.Jones.
J. chem. Phys., Vol. 31, No. 5, 1317-19 (Nov., 1959).

An effective one-electron Hamiltonian for molecules is presented that gives exactly the single-atom energies for its diagonal elements. An operator is used that selectively cancels the nuclear attraction for all nuclei except the one on which a particular AO is centered.

539.19

2749 LIGAND FIELD BANDS OF FOUR-COORDINATED PARAMETRIC NICKEL (II) COMPLEXES.

C.K.Jørgensen.
Molecular Phys., Vol. 1, No. 4, 410-12 (Oct., 1958).

The levels for the tetrahedral complex $NiCl_4^{2-}$ are calculated using the general assumption that Δ for tetrahedral complexes is −4/9 times that of the corresponding octahedral complex. The absorption spectrum of one species of Ni(II) in salt melts conforms closely to this predicted pattern and it is concluded that tetrahedral coordination of the ligands occurs. The unusually high intensity of the visible, spin-allowed ligand field band for Co(II) complexes, ε between 500 and 2000, can be explained if the cobalt complexes have much stronger bands at higher wave-numbers than the corresponding Ni(II) complexes where ε = 61. W.J.Orville-Thomas

539.19

2750 STUDY OF THE STRUCTURE OF THE FHF^- ION BY THE CONFIGURATION INTERACTION METHOD.

S.Bratož and G.Bessis.
C.R. Acad. Sci. (Paris), Vol. 249, No. 19, 1881-3 (Nov. 9, 1959).
In French.

A simplified calculation based on Hartree–Fock and Slater orbitals leads to 11 configurations and gives 4.83 eV for the bond energy in the ground state (experimental 4.30 eV). All excited states are predicted to be unstable. J.Hawgood

539.19

2751 EXISTENCE OF N_2O_4 ISOMERS.

I.C.Hisatsune and J.P.Devlin.
J. chem. Phys., Vol.31, No.4, 1130-1 (Oct., 1959).

Temperature dependence studies of the infrared spectrum of the solid state confirm the existence of a nonplanar (V_d symmetry) isomeric form of N_2O_4. W.J.Orville-Thomas

539.19

2752 MICROWAVE SPECTRUM AND STRUCTURE OF N_2F_4. D.R.Lide, Jr and D.E.Mann.
J. chem. Phys., Vol. 31, No. 4, 1129-30 (Oct., 1959).

A microwave investigation of N_2F_4 establishes that the molecule has a hydrazine-like structure (point group C_2). In the absence of isotopic studies a complete structural determination is impossible but the following reasonable estimates fit the observed moments of inertia : r(NN) = 1.47 A, r(NF) = 1.37 A, ∠FNF = 102°, ∠NNF = 104°. Preliminary measurements indicate a dipole moment of about 0.26 D and a barrier hindering internal rotation of the NF_2 groups greater than 3 kcal/mole. W.J.Orville-Thomas

539.19

2753 INTERMOLECULAR FORCES IN QUASI-SPHERICAL MOLECULES. II. J.C.McCoubrey and N.M.Singh.
Trans Faraday Soc., Vol. 55, Pt 11, 1826-30 (Nov., 1959).

For Pt I see Transactions of the Faraday Society, Vol. 53, Pt 7, 877-83 (July, 1957). The collision integrals necessary for the calculation of transport coefficients of gases have been computed for an intermolecular potential of the form $\phi(r) = A/r^{12}-B/r^{7}$, where r is the distance between molecular centres. These integrals have been used in combination with existing second virial coefficient computations to test the suggestion that the 28 : 7 potential describes the form of the intermolecular interactions which may be considered to occur between the centres of quasi-spherical molecules such as CF_4, SF_6, SiF_4, or $C(CH_3)_4$. It is shown that such a potential approximation constitutes an improvement over the usual Lennard-Jones 12 : 6 potential for three of the quasi-spherical molecules, but it cannot be used to give a completely satisfactory correlation of the transport and equilibrium properties of these molecules.

539.19

2754 DEACTIVATION OF THE VIBRATION DURING THE COLLISION OF TWO DIATOMIC MOLECULES.
K.F.Herzfeld.
Z. Phys., Vol.156, No.3, 265-70 (1959).

A method has been developed to calculate the cross-section for the de-excitation of a vibrational degree of freedom by collision between two diatomic molecules. The orientation of the molecules has been taken into account. Apart from the steric factor the result is identical with that obtained previously for the collision of a diatomic molecule and an atom. W.J.Orville-Thomas

539.19 : 539.18

2755 MEASUREMENT OF EXCITATION OF N_2, CO, AND He BY ELECTRON IMPACT. G.J.Schulz.
Phys. Rev., Vol. 116, No. 5, was 1141-7 (Dec. 1, 1959).

The inelastic excitation of N_2 and CO by electron impact was studied using the trapped-electron method (Abstr. 3956 of 1959). In this method those electrons which have lost a portion of their initial energy in an inelastic collision are trapped in a potential well. Well depths up to 3 V were used in the present experiment. The operation of the apparatus was checked for helium, where the shape of the excitation function is known accurately. The shape of the excitation function for metastable helium atoms obtained by the trapped-electron method is in good agreement with previous results. A large inelastic peak is observed at 2.3 eV in N_2 and 1.7 eV in CO. This phenomenon is discussed in terms of the formation of a temporary negative ion state of N_2 or CO and subsequent decay into various vibrational levels of the molecule. This model explains the sharp peak in both the elastic and inelastic cross-section in N_2 and CO. Neither O_2 nor H_2 show such a sharp peak at low energies.

539.19

2756 LOCAL STERIC HINDRANCES AND CONFIGURATIONS OF LINEAR MACROMOLECULES IN SOLUTIONS. I. FORMULATION. K.Nagai.
J. chem. Phys., Vol. 31, No. 5, 1169-74 (Nov., 1959).

The previous theory treating the analogous problem is developed to include rigorously the interactions between the atomic groups whose relative spatial configurations are determined by the rotational angles of two neighbouring skeletal bonds. The mean-square end-to-end distances and/or the electric moments are calculated for isotactic- and syndyotactic-vinylic macromolecules as well as a few other macromolecules with similar structures. As a model for linear macromolecules is adopted the discrete one whose each C—C bond is assumed to take only three rotational configurations (e.g., trans, gauche, and another gauche). In such a model the problem of taking all of the interactions between neighbouring bonds into account is equivalent to that of a one-dimensional cooperative system. While the partition function of this system can be obtained easily, some techniques are required to find the mean quantities under consideration. Results obtained involve the task of evaluating the trace of a certain matrix of nine degrees.

539.19

2757 MOLECULAR BEAMS. O.R.Frisch.
Contemporary Physics, Vol. 1, No. 1, 3-16 (Oct., 1959).

A general account of the history of the development of molecular beams for physical research, and the major experiments performed with their aid.

539.19

2758 THEORY AND APPLICATION OF MOLECULAR-BEAM TECHNIQUES FOR THE DESIGN OF COLLISION-FREE SAMPLING SYSTEMS. I. MOLECULAR-BEAM FORMATION BY MULTIPLE APERTURE COLLIMATING SYSTEMS.
C.W.Nutt, J.S.M.Botterill, G.Thorpe and G.W.Penmore.
Trans Faraday Soc., Vol. 55, Pt 9, 1500-15 (Sept., 1959).

Molecular beams formed by argon, oxygen, ethane and isobutane in five types of triple-aperture collimating systems were studied using a mass spectrometer to determine the beam intensity. Measurements were made of the intensity of the direct beam and the magnitudes of the contributions from background gas in the three collimating regions. Gas in the first collimating chamber made the largest background contribution by two mechanisms. The first, which predominated for long path-lengths in the first collimating region, was molecular effusion of the background gas from this region through the second aperture. The second, which predominated when the path length in the first collimating region was less than 3 cm, was due to knocking-on collisions between the main molecular beam and background gas. The experimental observations were in quantitative agreement with theoretical expressions for the magnitudes of these processes. The magnitude of the scattering out of the main molecular beam showed that the collision diameter for scattering was about twice the diameter derived from the viscosity of the gases. When cold traps and outgassing procedures were not used for the first collimating region, additional scattering was observed and its magnitude suggested the presence of a high-molecular-weight gas at a pressure of the order 10^{-5}-10^{-4} mm Hg.

539.19

2759 THEORY AND APPLICATION OF MOLECULAR-BEAM TECHNIQUES FOR THE DESIGN OF COLLISION-FREE SAMPLING SYSTEMS. II. MOLECULAR-BEAM FORMATION BY ADIABATIC EXPANSION OF GAS THROUGH APERTURES IN THIN DIAPHRAGMS. C.W.Nutt, G.W.Penmore and A.J.Biddlestone.
Trans Faraday Soc., Vol. 55, Pt 9, 1516-23 (Sept., 1959).

Flow rates and molecular-beam formation for the flow of argon through small round apertures in metal foil have been investigated over a range of pressures up to a maximum at which the mean free path upstream of the aperture was less than 1/50th of the aperture diameter. The results showed that the gas flow-rate changed from molecular effusion to adiabatic expansion in this pressure range. The molecular-beam intensity continued to increase with upstream pressure throughout this pressure range in agreement with theoretical predictions. The results also suggested that, in agreement with theory, the velocities of the molecules in the molecular beam formed by adiabatic expansion were the sum of the acoustic and the thermal velocities.

539.19

2760 ATTEMPT AT EXCITING THE DECOMPOSITION OF ClO_2 IN A HOT N_2 BEAM, AND THE ENERGY OF DISSOCIATION OF NITROGEN.
H.Martin, H.Harnisch and M.Pohl.
Z. Elektrochem., Vol. 63, No. 6, 645-51 (1959). In German.

No appreciable decomposition of ClO_2 was achieved in the molecular-beam furnace [H.Martin and H.J.Meyer, Abstr. 5375 of 1952; Z.Elektrochem., Vol. 56, No. 8, 740-2 (1952)] when using N_2 or A beams at temperatures of about 2700° K. The estimated collision yield is less than 4×10^{-4}. The findings are explained by the very high energy of activation of the unimolecular decomposition of ClO_2 and by the extremely small proportion of the total kinetic relative energy of the collision pair being transformed into the

vibrational energy of ClO_2 even in the case of a fully inelastic collision. It appears that the dissociation energy of N_2 equals 225 rather than 170 kcal. F.Lachman

539.19

2761 THEORY OF THE FINE STRUCTURE OF THE MICROWAVE SPECTRUM OF NO_2. C.C.Lin.

Phys. Rev., Vol. 116, No. 4, 903-10 (Nov. 15, 1959).

Experimental work on the microwave spectrum has been summarized by Bird (Abstr. 2046 of 1957). The effects of the magnetic interactions between the electronic spin, nuclear spin, and molecular rotation on the rotational energy levels of NO_2 molecule are investigated and a theory of the fine structure of the microwave spectrum of this molecule is presented. A new method for calculating the matrix elements of the magnetic interaction terms has been developed. Possible extension of this theory to include the general type of polyatomic molecules with $S = \frac{1}{2}$ is discussed.

539.19

2762 MICROWAVE SPECTRUM, INTERNAL BARRIER, STRUCTURE, CONFORMATION, AND DIPOLE MOMENT OF ACETYL FLUORIDE. L.Pierce and L.C.Krisher.

J. chem. Phys., Vol.31, No.4, 875-82 (Oct., 1959).

The microwave spectra of eight isotopic species of acetyl fluoride are reported. Interaction of internal and over-all rotation splits the rotational lines into doublets. From the doublet separations of CH_3COF the height of the threefold (sinusoidal) barrier to internal rotation was calculated to be 1041 cal/mole. Splittings in the spectra of $C^{13}H_3COF$, $CH_3CO^{18}F$, and CD_3COF gave barriers of 1041, 1055, and 1031 cal/mole, respectively. With the assumption of a symmetrical methyl group, the following structural parameters were determined from the observed rotational constants:

C–C	1.503 A	CCF	110°18'
C–F	1.348	CCO	128°21'
C–O	1.181	HCH	109°30'
C–H	1.084		

If the requirement of methyl group symmetry is dropped, the best fit to all the data is obtained with the following methyl group parameters:

	In-plane hydrogen	Out-of-plane hydrogens
C–H	1.082 A	1.096 A
CCH	110°24'	108°48'
HCH	110°51'	107°16'

The observed rotational constants of CH_2DCOF and CHD_2COF were found to require the H (in-plane)–F trans-equilibrium conformation. From Stark effect measurements on CH_3COF and $CH_3CO^{18}F$ the dipole moment was calculated to be 2.96 D. The dipole moment makes an angle of 9°30' with the C–C bond axis and is directed toward the oxygen atom.

539.19

2763 MICROWAVE SPECTRUM OF ACETYL CYANIDE. L.C.Krisher and E.B.Wilson, Jr.

J. chem. Phys., Vol.31, No.4, 882-9 (Oct., 1959).

The microwave spectra of eight isotopic species of acetyl cyanide were investigated in the region 8000 to 34 000 Mc/s. The hindered internal rotation of the methyl group splits some of the rotational lines into doublets. Analysis of these splittings for four isotopic species gives a barrier to internal rotation of 1270 ± 30 cal/mole. From the rotational constants of CH_3COCN, $C^{13}H_3COCN$, $CH_3COC^{15}N$, $CH_3CO^{18}CN$, CD_3COCN, and $CD_3C^{13}OCN$ the following structural parameters were determined:

C–H	1.086 ± 0.005 A	∠HCH	108° 44' ± 30'
C=O	1.226 ± 0.005	$\angle C_{methyl}CO$	124° 3' ± 1°
C≡N	1.164 ± 0.005	∠CCC	114° 59' ± 1°
$C_{methyl}–C_{carbonyl}$	1.490 ± 0.010	∠CCN	180° (assumed)
$C_{carbonyl}–C_{cyanide}$	1.466 ± 0.010		

A study of CH_2DCOCN and CHD_2COCN shows that in its equilibrium configuration, the acetyl cyanide molecule has a methyl hydrogen opposite the oxygen atom. A dipole moment of 3.45 D was obtained from Stark effect measurements.

539.19

2764 INFRARED SPECTRA OF VINYL CHLORIDE AND VINYL CHLORIDE-d_3.

S.Narita, S.Ichinohe and S.Enomoto.

J. chem. Phys., Vol. 31, No. 5, 1151-7 (Nov., 1959).

Vinyl chloride-d_3 was prepared and the infrared spectrum obtained in the region from 400 to 4000 cm^{-1}. The spectrum is compared with that of vinyl chloride. Normal coordinate analyses are made for vinyl chloride and vinyl chloride-d_3. A force field of the Urey–Bradley type is used for the planar vibrations, and a modified valence-type potential function is applied to the nonpolar motions. The vibrational secular equations are set up in the GF matrix fashion. The force constants are determined by a least-square process. The force constants established for vinyl chloride are used to calculate the fundamental frequencies of vinyl chloride-d_3. Satisfactory results are obtained.

539.19

2765 A $^2\Pi$-$^2\Pi$ ELECTRONIC BAND SYSTEM OF THE FREE NCO RADICAL. R.N.Dixon.

Canad. J. Phys., Vol. 38, No. 1, 10-16 (Jan., 1960).

A series of red-degraded absorption bands has been observed between 2650 A and 3200 A and is attributed to a $^2\Pi$-$^2\Pi$ transition of the NCO radical. The bands probably represent a progression of the upper-state stretching vibration ν'_1. The rotational structure of one band has been analysed. Diffuseness in some of the bands indicates predissociation of the upper state, and is discussed in terms of the dissociation energy of NCO.

539.19

2766 ROTATIONAL ANALYSIS OF THE COLUMBIUM [NIOBIUM] OXIDE BANDS. K.Suryanarayana Rao.

Proc. Nat. Inst. Sci. India A, 219-37 Vol.21, No.4, (July 26, 1955).

The spectrum of columbium oxide has been photographed in the first and second orders of a 21 ft, 30 000 lines per inch concave grating with dispersions of 1.2 A/mm and 0.6 A/mm respectively. The rotational analysis of the (1, 0), (0, 0) and (0, 1) bands of system A at λλ 4510, 4689 and 4915 respectively in this spectrum has been carried out for the first time. As in vanadium oxide, four distinct branches, namely R_1, R_2, P_1 and P_2, have been identified in each band. The rotational constants, calculated by the least squares method, are reported.

539.19

2767 FURTHER INVESTIGATIONS ON COLUMBIUM [NIOBIUM] OXIDE BANDS. K.Suryanarayana Rao.

Proc. Nat. Inst. Sci. India A, Vol.21, No.3, 188-95 (May 28, 1955).

A further study of sharply focused photographs of the (1, 0), (0, 0) and (0, 1) bands of system A of colombium oxide led to the detection of a satellite branch in each band, in addition to the main P and R branches (see preceding abstract). A discussion is given of the electronic transition of the band system. This is indicated to be probably a $^4\Sigma$–$^4\Sigma$, corresponding to which there is no band system as yet known.

539.19

2768 BAND SPECTRUM OF MANGANESE OXIDE (MnO). J.M.Das Sarma.

Z. Phys., Vol. 157, No. 1, 98-105 (1959). In German.

New measurements of the wavelengths of the band heads have been made. In all 57 band heads, including 15 hitherto unrecorded ones, have been measured. The equation representing the wavenumber of a band head has been modified as,

$$\nu = 17949.19 + \{762.75(v' + \tfrac{1}{2}) - 9.60(v' + \tfrac{1}{2})^2 + 0.06(v' + \tfrac{1}{2})^3\} - \{839.55(v'' + \tfrac{1}{2}) - 4.79(v'' + \tfrac{1}{2})^2\}.$$

The dissociation energies of the upper and the lower states have been calculated as $D'_0 = 2.8$ eV and $D''_0 = 4.1$ eV, respectively. The potential energy curves for both the states have been drawn after Morse, and the transition probabilities ascertained and compared with the visual estimates of intensities of the various band heads. The probable dissociation products in the two states are also discussed.

539.19

2769 STARK EFFECT AT 0.93, 1.18, AND 1.5 MILLIMETERS WAVELENGTH: DCl, DBr, AND DI. C.A.Burrus.

J. chem. Phys., Vol. 31, No. 5, 1270-2 (Nov., 1959).

Observations of the Stark effect in the microwave rotational spectra of light molecules have been extended into the sub-millimetre wave region. The Stark shifts of the $J = 0 \rightarrow 1$ transition of deuterium chloride at 0.93 mm wavelength, and of deuterium bromide at 1.18 mm have been measured. Values of the molecular electric dipole moment μ, obtained from analysis of the data, are found to be 1.12 ± 0.04 debye for DCl and 0.83 ± 0.02 debye for

DBr. An error in the calculation of μ for DI, from measurements at 1.5 mm previously reported, is corrected, and μ for DI is found to be 0.445 ± 0.02 debye.

539.19

2770 SPECTROSCOPIC EVIDENCE FOR THE ENHANCEMENT BY DISSOLVED SALTS OF THE MOLE RATIO OF THE GAUCHE TO THE TRANS FORM OF ETHYLENE CHLORIDE.
Y.H.Inami and J.B.Ramsey.
J. chem. Phys., Vol. 31, No. 5, 1297-301 (Nov., 1959).

The infrared absorption spectra of two solutions of tetra-n-butylammonium perchlorate in ethylene chloride, 0.77 and 1.23 v.f., respectively, were determined at ~ 25° C. By comparison of these spectra with the spectrum of pure ethylene chloride it is shown that the mole ratio of the gauche to the trans form of ethylene chloride in each of these salt solutions (1.69 and 1.92, respectively) is significantly greater than it is in pure ethylene chloride (1.3). The degree of dissociation of the salt in each of the two solutions is estimated from the measured values of their equivalent conductance-viscosity products. On this basis it is shown that in each of the solutions an appreciable fraction of ethylene chloride exists near enough to an ion to be appreciably influenced by its electric field.

539.19 : 539.2 : 548.7

LOW-TEMPERATURE X-RAY DIFFRACTION STUDY OF THE PRODUCTS OF A MICROWAVE DISCHARGE IN DIBORANE. See Abstr. 1914

SOLID-STATE PHYSICS

539.2

2771 ON NONCROSSING LATTICE POLYGONS.
G.S.Rushbrooke and J.Eve.
J. chem. Phys., Vol. 31, No. 5, 1333-4 (Nov., 1959).

Numerical data on nonselfcrossing closed polygons on simple-cubic and plane-square lattices are presented and discussed in connection with the Monte Carlo investigations of Wall and others on the restricted random walk problems for these lattices.

539.2

2772 A STATISTICAL THEORY OF THE BINDING ENERGY OF SPINEL-TYPE CRYSTALS.
A.N.Orlov and A.N.Men'.
Fiz. tverdogo Tela, Vol. 1, No. 2, 195-202 (Feb., 1959). In Russian.

The binding energy is discussed using a model with oxygen ions represented by a "background" potential V_i in which interactions between metal ions take place. The Thomas–Fermi equation is solved for a spinel-type crystal with non-uniform electron density. The general expressions obtained in this way are used to deal with a simple case of uniform electron density in a mixed spinel. The results obtained for the binding energy and the lattice constant as functions of the composition and the degree of inversion are in qualitative agreement with experimental data for a number of mixed spinels. A.Tybulewicz

539.2

2773 CALCULATION OF THE COHESIVE ENERGY OF METALLIC IRON. F.Stern.
Phys. Rev., Vol. 116, No. 6, 1399-417 (Dec. 15, 1959).

The cohesive energy of metallic iron is calculated for the body-centred cubic structure in a singlet spin state at 0°K. The potential field acting on each electron is taken to be that of the ion core and of the remaining valence electrons in the same lattice cell; thus the calculation becomes equivalent to one for the free atom as the lattice constant is increased. Tight-binding wave-functions are used, but they are modified by expanding the contributions from neighbouring atoms in a power series within a cell, and orthogonalizing to core states. Evaluating the complete wave-function in each cell eliminates the need for multicentre integrals otherwise required in the tight-binding method. The wave-functions for wave vectors in directions of high symmetry have a rather simple form, and can be described by a few parameters. States near the bottom of the 3d band tend to have a more diffuse charge distribution than do the states near the top of the band. Thus the X-ray scattering factor per electron for a partially filled 3d band will be less than that for a full band. Calculations of the energy of the solid are made for three values of the atomic sphere radius, r_s, using atomic wave-functions from the $3d^7 4s$ configuration. The indicated configuration in the solid is close to $3d^7 4s$, making the calculation approximately self-consistent. The calculated width of the occupied portion of the 3d band is 0.33 ry. The cohesive energy of metallic iron is found to be 0.43 ± 0.2 ry per atom, which is consistent with the experimental value, 0.32 ry. The equilibrium lattice constant and the compressibility are both found to be in good agreement with experiment. An attempt to replace the Coulomb hole used in the main calculation by an exchange hole, using a single Slater determinant wave-function, gave far too little binding.

539.2

2774 EFFECT OF PRESSURE ON THE MELTING POINTS OF EIGHT ALKALI HALIDES. S.P.Clark,Jr.
J. chem. Phys., Vol. 31, No. 6, 1526-31 (Dec., 1959).

The melting curves of the alkali chlorides and the sodium halides were determined at high pressures. The results can be represented within experimental error by Simon's equation. Comparison of the slope of the melting curve at low pressure with measurements of the changes of volume and entropy upon fusion suggests that the latter data are systematically in error.

539.2

2775 ELECTRONIC STRUCTURE OF TRANSITION METALS.
W.Marshall and R.J.Weiss.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 220S-224S (April, 1959).

Several distinct lines of experimental work now point towards a new conception of the electronic structure of the transition metals. Recent X-ray work by Weiss (Abstr. 3583 of 1958) suggests that metals of atomic number less than Fe and Fe itself have few 3d electrons and many conduction electrons while for metals above Fe this is reversed. These results are discussed and the ideas to which they lead described. On this basis the magnetic properties of all the pure metals are easily understood and the variation of the saturation moments of all the binary ferromagnetic alloys can be explained. Results of neutron diffraction on ferromagnetic alloys also support the new ideas and further experiments should provide very clear tests of them. It is shown that these alloys can be divided into four types each with a characteristic behaviour. Further evidence, coming from recent unpublished work, is also briefly mentioned.

539.2

2776 ON THE USE OF THE POSITRON FOR STUDYING THE ELECTRONIC STRUCTURE OF METALS. E.Daniel.
J. Phys. Radium, Vol. 18, No. 12, 691-2 (Dec., 1957). In French.

Experiments were carried out utilizing the γ-rays emitted by positron annihilation. A theoretical study shows that the very strong electron–positron interaction makes it difficult to analyse the experimental results.

539.2 : 539.12

PROBABILITY FOR POSITRONIUM FORMATION IN THE ELECTRON GAS OF A METAL. See Abstr. 2533

Lattice Dynamics

539.2

2777 THE USE OF THE REPULSIVE POTENTIAL IN THE QUANTUM THEORY OF SOLIDS. E.Antončík.
Czech. J. Phys., Vol. 9, No. 3, 291-305 (1959).

A new method is proposed for calculating the energy at certain special points of the Brillouin zone. The wave functions of valence and conduction electrons are given in the form of the linear combination of plane waves, and the orthogonality condition of these functions to the wave-functions of lower states is replaced by the repulsive potential. The practical application of this very simple method is illustrated on the energy spectrum of silicon in the centre of the Brillouin zone. It is proved that the results are comparable with some other methods, e.g. the orthogonalized plane-wave method.

539.2

2778 APPROXIMATE FORMULATION OF THE ORTHOGONALIZED PLANE-WAVE METHOD. E.Antončík.
J. Phys. Chem. Solids, Vol. 10, No. 4, 314-20 (Aug., 1959).

An approximate method is derived for calculating the energy band of solids, analogous to the orthogonalized plane-wave method. In this method the exact condition for the orthogonality of the wave-functions of valency electrons to the wave-functions of the electrons of ions is replaced by a repulsive potential determined statistically. It is shown by the example of the energy spectrum of diamond that despite the relative simplicity of this method, its results are comparable to those given by other methods. Correlation is also carried out between this method and the Phillips energy-band interpolation scheme.

539.2

2779 EQUATION OF STATE OF POTASSIUM CHLORIDE. S.Shivananda Tolpadi.
J. sci. Res. Banaras Hindu Univ., Vol. 8(2), 148-57 (1957-58: publ. June, 1958).

The usual thermodynamic method has been used to draw the isotherms of potassium chloride at several temperatures from T = 750°K to 1250°K. The static pressure due to a nonvibrating lattice has been calculated as a function of the molar volume by the use of the standard expression for the potential energy of ionic crystals as given by Huggins and Mayer. Grüneisen constants have been calculated at different volumes for 25 modes of vibrations, 4 of which represent the limiting vibrations of the octahedral and 18 those of the cubic planes. The remaining 3 vibrations correspond to the triply degenerate vibration of the potassium and chlorine atoms against each other. From these Grüneisen constants an average constant has been calculated as a function of the molar volume. The thermal pressures have been calculated from the average Grüneisen constants and the classical expression of the thermal energy. The isotherm at nearly 1100°K is found to show a minimum, touching the axis of zero pressure. This is a few % higher than the observed melting point as expected from thermodynamic principles.

539.2

2780 NON-CENTRAL FORCES IN THE THEORY OF VIBRATIONS OF A CRYSTAL LATTICE. B.Ya.Moizhes.
Fiz. tverdogo Tela, Vol. 1, No. 11, 1770-4 (Nov., 1959). In Russian.

A simple model of a cubic crystal is considered in which each atom is connected to its nearest neighbours by valency bonds possessing rigidity with respect to tension and bending. By considering rotation of the valency bonds, the frequency determinant is derived and evaluated explicitly for the [100], [111], and [100] directions. The dynamic elastic constants derived from the model are the same as for the static case. R.F.S.Hearmon

539.2

2781 USE OF THE SELF-CONSISTENT FIELD IN THE TREATMENT OF THE VIBRATIONS OF CRYSTALS. T.H.Walnut.
J. chem. Phys., Vol. 31, No. 6, 1468-70 (Dec., 1959).

It is shown that quantum-mechanical average equilibrium positions and average normal coordinates of ordered crystals are useful quantities. It is found that the wave-functions calculated using these average quantities are more tractable approximations than those calculated from the true potential function with neglect of cubic and higher terms. A self-consistent field treatment is used to show how the average equilibrium positions and average normal coordinates could be obtained in principle. The wave-functions derived from the self-consistent field coordinates are still very poor approximations to the exact wave-functions in the sense that the projections of an approximate wave-function on any exact wave-function is extremely small.

539.2

2782 LATTICE VIBRATIONS IN ALKALI HALIDE CRYSTALS. I. LITHIUM AND SODIUM HALIDES.
J. chem. Phys., Vol. 31, No. 6, 1489-99 (Dec., 1959).

Vibrational frequency distributions for the lithium and sodium halides were evaluated on the basis of the Born lattice theory by the use of Blackman's numerical-sampling technique. Both room temperature and extrapolated 0°K parameters were used in the calculation. Specific heats, the corresponding Debye characteristic temperatures, and the moments of the distributions were evaluated directly from the frequencies. Comparison is made with experimental data and with other theoretical work.

539.2 : 539.18

2783 LATTICE ENERGIES OF THE ALKALI HALIDES AND THE ELECTRON AFFINITIES OF THE HALOGENS. D.Cubicciotti.
J. chem. Phys., Vol. 31, No. 6, 1646-51 (Dec., 1959).

The overlap repulsion parameters that occur in the Born–Mayer treatment of lattice energies have been re-evaluated for the alkali halides from recent compressibility data. With these parameters the lattice energies of the alkali halides were calculated. The lattice energies were combined with thermochemical data to calculate the electron affinities of the halogens. The values obtained were: F 80.2; Cl 85.0; Br 79.5; and I 72.5 kcal/mole.

539.2

2784 SOLUTIONS FOR THE SECULAR DETERMINANT ON THE BRILLOUIN ZONE FACES FOR FACE-CENTERED CUBIC LATTICE VIBRATIONS. W.C.Overton, Jr.
Phys. Rev., Vol. 116, No. 4, 851-2 (Nov. 15, 1959).

The contours of constant frequency of the longitudinal branch are plotted on the hexagonal Brillouin zone face to aid in the study of the vibration spectra of the two-force constant model for face-centred cubic lattices. These contours are based on machine solutions of the secular determinant as well as on closed-form solutions along the edge lines of the $\frac{1}{8}$th portion of the hexagonal face cut by the planes of the irreducible trihedral angle (1/48 zone). Newly found closed-form solutions along the bisectrix of the $\frac{1}{8}$th portion provide greater accuracy of the contours. The graphical study has disclosed new types of critical points on the hexagonal zone faces.

539.2

2785 MOMENTS OF FREQUENCY SPECTRUM AND THERMODYNAMIC FUNCTIONS OF CRYSTALS WITH DEFECTS. O.Litzman.
Czech. J. Phys., Vol. 9, No. 6, 692-700 (1959).

The method for calculating the vibrational frequencies of a perturbed crystal lattice, elaborated previously (Abstr. 5129, 12775 of 1959) is combined with the "method of contour integral" to calculate the additive functions of the frequencies (Montroll). This leads to a formula which can be used to calculate the changes caused by a defect in the even moments of the frequency spectrum without knowing the spectrum of the unperturbed or perturbed crystal. The changes in thermodynamic functions and specific heat can be approximated by means of these changes in moments. The change is also calculated in the frequency spectrum of a monatomic chain, caused by one foreign atom; this calculation is confined to the isotopic effect.

539.2

2786 THE SPECIFIC HEAT OF COPPER FROM 20° TO 300°K. D.L.Martin.
Canad. J. Phys., Vol. 38, No. 1, 17-24 (Jan., 1960).

The specific heats of commercially pure cold-rolled copper and of annealed and heavily cold-worked 99.999% pure copper have been measured in the temperature range 20°-300°K. When results are averaged over the whole temperature range of measurement the specific heat of the pure cold-worked copper is about 0.15% above that of the pure annealed sample while results for the commercially pure cold-rolled material lie in an intermediate position. Results on a given sample are reproducible within 0.05%. The entropy of pure annealed copper at 298.15°K is 7.92 ± 0.04 cal/°K g atom.

539.2

2787 THE SPECIFIC HEAT OF A LITHIUM-MAGNESIUM ALLOY. THE MARTENSITIC TRANSFORMATION. D.L.Martin.
Canad. J. Phys., Vol. 38, No. 1, 25-31 (Jan., 1960).

The specific heat of an alloy of lithium with 0.95 at.% magnesium has been measured from 20°-300°K. The specific heat of the body-centred cubic phase is less than that calculated from the Kopp–Neumann rule. A specific heat anomaly, due to the martensitic transformation, is observed and has almost the same heat content as the corresponding anomaly for pure lithium but the high temperature end is of significantly different shape.

539.2 : 536.63

2788 HEAT CAPACITY OF SAMARIUM FROM 13 TO 350°K. L.D.Jennings, E.D.Hill and F.H.Spedding.
J. chem. Phys., Vol. 31, No. 5, 1240-3 (Nov., 1959).

Samarium shows anomalies in its heat capacity near 13°K and

at 105.8°K. The former has already been shown to be magnetic in origin; it appears certain that the latter is also, although there is only a slight sign of an anomaly in the magnetic data near 105°. The magnetic ordering does not appear to be explicable on the assumption of an isotropic S-S coupling mechanism. The thermodynamic functions are tabulated for the temperature region studied.

539.2 : 536.63

2789 SOME PHYSICAL PROPERTIES OF NEPTUNIUM METAL. I. A DETERMINATION OF THE SPECIFIC HEAT OF α-NEPTUNIUM. J.P.Evans and P.G.Mardon.
J. Phys. Chem. Solids, Vol. 10, No. 4, 311-13 (Aug., 1959).

The specific heat over the α-phase range was determined by a simple calorimetric method. The value of C_p increases from 0.031_4 cal/g at 60°C to 0.40_3 cal/g at 207°C. In a separate determination, the latent heat of the $\alpha \rightarrow \beta$ transformation was found to be 2.0 ± 0.2 kcal/mole.

539.2 : 536.63

2790 THE SPECIFIC HEAT OF CRYSTALS. I. GENERAL THEORY. II. THE CASE OF DIAMOND. III. ANALYSIS OF THE EXPERIMENTAL DATA. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 44, No. 4, 153-9, 160-4 (Oct.); 367-74 (Dec., 1956).

539.2 : 536.63

2791 THE SPECIFIC HEATS OF SOME METALLIC ELEMENTS. I. ANALYSIS OF THE EXPERIMENTAL DATA. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 45, No. 1, 1-6 (Jan., 1957).

The specific heat data in the temperature range from 15° to 300°K reported by Giauque and collaborators for the four metals aluminium, copper, silver and lead are analysed, and the effective average frequency of the atomic oscillators deduced from the analysis is plotted as a function of the temperature. The graphs exhibit a steep fall of the effective frequency at very low temperatures as is to be expected. In the middle part of the temperature range, the frequency exhibits a broad maximum which in spectral wave-numbers is respectively 206, 167, 113 and 50 for the four metals. At higher temperatures the graph exhibits a second fall which indicates that there is a real and progressive diminution of the actual vibration frequencies of the atoms in the crystal with rising temperature in this range. The effect becomes increasingly more pronounced with increasing atomic mass.

539.2 : 536.63

2792 THE SPECIFIC HEATS OF SOME METALLIC ELEMENTS. II. APPROXIMATE THEORETICAL EVALUATION. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 45, No. 1, 7-14 (Jan., 1957).

The specific heats of the four metals discussed in Pt I are calculated in terms of the four characteristic frequencies of vibration of a f.c.c. lattice, the latter being determined by an approximate method which relates them to the elastic constants of the crystal. The results thus derived are discussed and compared with the experimentally determined specific heats.

539.2 : 536.63

2793 THE SPECIFIC HEATS OF SOME METALLIC ELEMENTS. III. THE CHARACTERISTIC FREQUENCIES. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 45, No. 2, 59-64 (Feb., 1957).

The specific heat data enable more precise calculations to be made of the four characteristic frequencies of each metal determined approximately in Pt II. Making use of the new values, the complete specific heat curve is theoretically deduced and shows good agreement with the observations in the lower part of the temperature range, but deviates observably in its upper part, as is to be expected in view of the progressive fall in the frequency of the atomic oscillators with rise of temperature indicated by the analysis of the data in Pt I. This diminution of the frequencies is a consequence of the anharmonicity of the oscillators which also results in the thermal expansion of the metal. Copper, aluminium, silver and lead form a sequence in the order of increasing coefficients of thermal expansion as also in the magnitude of the temperature coefficients of atomic vibration frequency indicated by their specific heat data.

539.2 : 536.63

2794 THE SPECIFIC HEATS OF SOME METALLIC ELEMENTS. IV. THE RESIDUAL SPECTRUM. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 45, No. 3, 139-46 (March, 1957).

The theoretical calculation of the specific heats of the four metals previously discussed have been extended down to the absolute zero. When the contribution arising from the thermal agitation from the electrons is included, the calculated specific heats are in satisfactory accord with the results reported by various investigators on the low temperature specific heats of these metals. The agreement is excellent in the cases of copper, silver and lead, but not so satisfactory for aluminium, the available data for which are meagre and appear to be of doubtful accuracy.

539.2 : 536.63

2795 THE HEAT CAPACITY OF DIAMOND BETWEEN 0 AND 1000°K. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol.46, No.5, 323-32 (Nov., 1957).

The evaluation of the heat capacity of diamond on the basis of the theory of specific heat advanced by the author is discussed and the results are compared graphically with the latest available experimental data. A striking over-all agreement emerges over the whole of the temperature range between 0 to 1000°K. The experimental values are, however, slightly in excess of the theoretical ones in the limited range between 50 and 150°K, the difference in the value of C_p being a maximum of 0.007 at about 100°K and above 150°K. This small excess is explained as a consequence of the use in the experimental determinations of industrial diamonds whose spectroscopic behaviour is observably different from that of the ideal material.

539.2 : 536.63

2796 THE SPECIFIC HEATS OF CRYSTALS AND THE FALLACY OF THE THEORIES OF DEBYE AND BORN. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 45, No. 5, 273-80 (May, 1957).

539.2

2797 THERMAL AND ELECTRICAL CONDUCTIVITIES OF RHODIUM AND IRON.
W.R.G.Kemp, P.G.Klemens and R.J.Tainsh.
Ann. Phys. (Leipzig), Folge 7, Vol. 5, No. 1-2, 35-41 (1959).
In German.

The very pure samples on which Grüneisen had carried out measurements in 1927 down to hydrogen temperatures were used for experiments down to 2°K. Results are in broad agreement with previous determinations and with existing theories. They are discussed in terms of phonon induced electronic scattering within the s-band and between the s- and the d-bands. L.Pincherle

539.2 : 536.2

2798 HEAT CONDUCTION IN SOME FERRIMAGNETIC CRYSTALS AT LOW TEMPERATURES. S.A.Friedberg.
J. appl. Phys., Supplement to: Vol. 30, No. 2, 218 (April, 1959).

A brief note only is given.

539.2 : 536.41

2799 THERMAL EXPANSION OF SILICON. L.Maissel.
J. appl. Phys., Vol. 31, No. 1, 211 (Jan., 1960).

Crystals approximately 2 inches long and $\frac{1}{4}$ inches square cross-section in an atmosphere of argon were measured by an optical lever method. Mean linear expansion coefficients for 100°C intervals covering the temperature range 50 to 850°C for the (111) and (110) crystal directions are tabulated. S.Weintroub

539.2

2800 STUDY ON THE CHANGE OF ULTRASONIC ATTENUATION BY STRESS IN STEEL. A.Takaoki.
J. Sci. Hiroshima, Univ. A, Vol. 23, No. 1, 65-84 (April, 1959).

Change of ultrasonic attenuation by several kinds of stresses in low-carbon steel was studied by using pulsed ultrasonic waves of 1 to 5 Mc/s and the following results were obtained: (1) Change of the attenuation by as much as 10^{-2} dB/cm by tension or compression within the elastic limit took place and in annealed steel was quite different from stretched steel. It is suggested that this is because steel has a tendency toward elastic formation of fibre structure attendant upon strain of the crystal lattice and change of orientation of the magnetic domains. (2) Attenuation change of as much as 10^{-3} dB/cm occurred due to magnetization of these specimens. It is considered that this change takes place with the movement of magnetic domain walls, and that characteristic change of the attenuation arises with the phenomena of magnetostriction in case

of stretched specimens. (3) Remarkable changes of attenuation occur if thermal stresses are permitted to remain in steel cylinders. Further, refraction phenomena occur on account of the residual stress distribution.

539.2

2801 SOUND ABSORPTION IN FERROMAGNETIC DIELECTRICS IN A MAGNETIC FIELD AT LOW TEMPERATURES. L.A.Shishkin.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 286-7 (July, 1958).
In Russian. English translation in: Soviet Physics - JETP (New York), Vol. 35 (8), No. 1, 197-8 (Jan., 1959):

Expressions are obtained for the absorption coefficient valid both for low fields (spin–spin interaction) and high fields (spin–lattice interaction). In both cases the phonons play a small role in sound absorption. D.J.Oliver

539.2

2802 SUPEREXCHANGE INTERACTION AND SYMMETRY PROPERTIES OF ELECTRON ORBITALS. J.Kanamori.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 87-98 (July, 1959).

The relation between the symmetry of electron orbitals and superexchange interaction is discussed. It is shown that the sign of the superexchange interaction is closely connected with the cation orbital state, when the cation is subject to the crystalline field arising from octahedrally or tetrahedrally surrounding anions. In some cases, the sign of the superexchange interaction is definitely determined from the symmetry relations. The cases in which each cation is subject to an octahedral cubic field and the lines connecting the interacting cations to the intervening anion make an angle of either 180° or 90° are discussed in particular. The present discussion of the 180° case is applicable to crystals of the perovskite type and NaCl type and that of the 90° case to anhydrous chlorides. In the case where each cation is subject to a tetrahedral cubic field, there is a definite relation between the symmetry of the cation electron orbitals and superexchange interaction, if only the s-orbital of anion participates in the superexchange interaction. TiH_2 is an example of this case. The interaction between nearest-neighbour cations in the crystal of the NaCl type is also discussed.

539.2

2803 EFFECT OF SPIN–ORBIT COUPLING ON THE ENERGY LEVELS IN THE 6d BAND FOR ACTINIDE METALS. G.W.Lehman.
Phys. Rev., Vol. 116, No. 4, 846-51 (Nov. 15, 1959).

The importance of spin–orbit coupling in modifying the energy levels in the 6d band for the actinide metals is discussed. The energy matrix, H_0, neglecting spin–orbit effects, is derived from Kohn's variational principle by expanding the wave-function in terms of the five atomic d orbitals having cubic symmetry. A single disposable parameter, E_d, occurs in this model such that $2E_d$ is the width of the d band. The spin–orbit energy matrix, H_{SO}, contains the spin–orbit splitting parameter, E_{SO}, which is equal to the $d_{5/2}$-$d_{3/2}$ level separation. The complete 10×10 energy matrix has been diagonalized analytically along a fourfold symmetry axis and numerically at 150 points in the Brillouin zone for the case $E_{SO}/E_d = 0.2$ appropriate to face-centred cubic thorium with $E_{SO} = 0.4$ eV and $E_d = 2$ eV. Plots of the energy variation along the two, three, and fourfold axes in the Brillouin zone are presented. Calculations based upon this model are also presented which show that the usual Pauli spin paramagnetism of the conduction electrons can be modified quite significantly by spin–orbit coupling.

539.2

2804 STATIONARY STATES OF AN ELECTRON IN THE FIELD OF A HOLE IN AN IONIC CRYSTAL. L.Hrivnák.
Czech. J. Phys., Vol. 9, No. 6, 685-91 (1959).

An approximate solution is given of the Schrodinger equation for S-states of an electron in the field of a hole, when the potential energy of the electron has the form

$$-e^2/r[1 + \exp(-qr)].$$

539.2

2805 FERMI SURFACE IN ALUMINUM. W.A.Harrison.
Phys. Rev., Vol. 116, No. 3, 555-61 (Nov. 1, 1959).

The band structure of aluminium is reconsidered in a combined experimental and theoretical approach very similar to that originally used by Heine (Abstr. 9292-4 of 1957). A more careful analysis of the de Haas–van Alphen data of Gunnersen has indicated a considerable flexibility in models consistent with it and has allowed the proposal of a Fermi surface which is much closer to that expected on theoretical grounds than the model suggested by Heine. It is found here that the first Brillouin zone is completely filled; that the second zone contains a single closed surface surrounding a region of holes; and that the third zone contains a multiply-connected surface which gives rise to all of the observed de Haas–van Alphen oscillations.

539.2

2806 INTERACTION OF NORMAL MODES WITH ELECTRON TRAPS. J.J.Markham.
Rev. mod. Phys., Vol. 31, No. 4, 956-89 (Oct., 1959).

An attempt to synthesise the rigorous quantum theory of interaction between normal modes and electron traps by reviewing and developing previous work using both phenomenological theory and the concept of local modes. The formulation of the Hamiltonian and deductions based on the Born–Oppenheimer technique are first discussed, followed by a detailed account of the broadening of absorption lines due to multiphonon processes. The author is concerned with developing a theory in a form suitable for later comparison with experimental results, but considers present data unreliable. J.W.Leech

539.2

2807 HOLE BANDS IN NaCl. T.I.Kucher.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1049-50 (Oct., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 732 (April, 1959).

An expression is given for the energy E(k) in terms of the wave number k for the NaCl lattice. From this is obtained the width of the principal band (2.17 eV), the longitudinal effective mass (0.539) and the transverse mass (0.98). J.Franks

539.2

2808 THE SPECTRUM OF ELEMENTARY EXCITATIONS OF THE ELECTRON SYSTEM OF A MONATOMIC NONCONDUCTING CRYSTAL. I. Z ELECTRONS PER ATOM. Yu.A.Izlyumov.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 4, 495-503 (1959).
In Russian.

The energy spectrum of the electron system of a weakly-excited crystal has several Bose branches. The effective number of electrons per atom does not change in the process of excitation. The excitation processes within an atom which involve change of electron spin and conservation of electron spin lead to different excitation states with no transitions between them. A.F.Brown

539.2

2809 THE PROPAGATION OF EXCITATION ENERGY IN PERTURBED CRYSTALS. M.Trlifaj.
Czech. J. Phys., Vol. 9, No. 6, 671-8 (1959).

The process of the propagation of excitation energy in perturbed dielectric crystals with a weak bond between the atoms having zero permanent dipole moment is studied. It is shown that on certain assumptions this process of propagation can be regarded as the motion of a Frenkel exciton in the electrostatic field of the defect. Frenkel's exciton can be characterized in this case as a neutral polarizable particle having induced dipole moment equal to the change in the induced dipole moment of the crystal during the excitation of one of its atoms.

539.2

2810 EXCITON STATES IN IONIC CRYSTALS. R.S.Knox and N.Inchauspe.
Phys. Rev., Vol. 116, No. 5, 1093-9 (Dec. 1, 1959).

Exciton states in ionic crystals are analysed according to configurations allowed by cubic point symmetry. The "excitation" and "electron transfer" models of the exciton structure are reintroduced as two slightly different aspects of the same general group-theoretical problem. Predictions of these models concerning multiplicity of absorption peaks are shown to be essentially identical. A theory of the "halogen atom doublet" appearing in the experimental absorption spectra of certain alkali halide crystals (see Abstr. 2937 of 1960) is given and is used in a preliminary interpretation of the electronic structure of low-lying exciton states in these solids.

539.2

2811 TEMPERATURE DEPENDENCE AND FORM OF THE LONG-WAVE EXCITON BAND IN KI CRYSTALS.
U.Haupt.
Z. Phys., Vol. 157, No. 2, 232-46 (1959). In German.

In the region of the first exciton band, the extinction coefficient of KI crystals was measured between 20° and 900°K, covering a range from 10^{-2} to 10^{6} mm^{-1}. Measurements were made on zone-refined single crystals, samples of KI melted between quartz plates, and thin evaporated layers. Below 400°K there are differences between the extinction curves measured on evaporated layers and on samples melted between quartz plates, which are ascribed to the higher concentrations of lattice defects in evaporated layers. The extinction coefficient on the long-wave tail of the exciton band depends exponentially upon frequency. This exponential band shape does not agree with the Gaussian or Lorentzian shape computed by Toyozawa [Progr. theor. Phys., Vol. 20, No. 1, 53-81 (July, 1958)].

539.2

2812 SLOW ELECTRONS IN POLAR CRYSTALS: SELF-ENERGY, MASS, AND MOBILITY. T.D.Schultz.
Phys. Rev., Vol. 116, No. 3, 526-43 (Nov. 1, 1959).

The parameters for the Feynman model of a polaron are evaluated numerically for various values of the electron lattice interaction α, in the usual idealization of the problem of a slow electron in a polar crystal. The self-energy and effective mass thus obtained are compared with earlier polaron theories, indicating the superiority of the Feynman model for a wide range of α. The polaron size and the effect of the continuum approximation are estimated, and it is concluded that the alkali halides, at least, may be in the border region for validity of this approximation. The problem of calculating polaron mobility as determined by scattering with longitudinal optical mode phonons is analysed and previous theories are critically reviewed. A new theory based on the Feynman model is developed in which the Boltzmann equation is used with resonance scattering considered as the fundamental scattering process. A comparison with previous theories shows some improvements and stresses still doubtful points. A comparison with various experiments suggests the possible inadequacy of the usual idealization.

539.2

2813 A VARIATIONAL CALCULATION OF ELECTRONIC TRANSPORT IN A MAGNETIC FIELD.
F.García-Moliner.
Proc. Roy. Soc. A, Vol. 249, 73-89 (Jan. 1, 1959).

The variational method is applied to the solution of the Boltzmann equation for an unbounded metal in a magnetic field. The formulae are thermodynamically consistent in any degree of approximation. For an anisotropic Fermi surface, a certain set of trial functions leads to an extension of Seitz's phenomenological formula, valid at arbitrary field strength for cubic crystals. At high fields the magneto-resistive effects should saturate and become isotropic. At intermediate fields the theory predicts strongly anisotropic effects in qualitative agreement with observation. At low fields the present approximation is compared with the exact theory of Jones and Zener (Abstr. 3032 of 1934). The numerical agreement is not perfect, but the fact that the longitudinal and transverse magneto-resistance may be of the same order of magnitude is explained.

539.2

2814 THEORETICAL MODEL FOR CUBIC TO TETRAGONAL PHASE TRANSFORMATIONS IN TRANSITION METAL SPINELS. P.J.Wojtowicz.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 30S-31S (April, 1959).

The detailed properties of the transformations from tetragonal to cubic phases which are observed at elevated temperatures are investigated. An approximate model has been constructed which explicitly takes into account the interactions between local Jahn–Teller distortions about neighbouring B-site transition metal cations. By the use of the usual method of statistical mechanics it has proved possible to derive the thermodynamic behaviour of this model. The principal result of importance is the demonstration that the transformations from tetragonal to cubic spinel phases are thermodynamically of the first order. That is, a latent heat, a volume discontinuity, lattice parameter discontinuities, and a lambda anomaly in the heat capacity are to be observed at the transformation temperature. The available evidence seems to support the conclusions drawn from the model.

539.2

2815 ON THE POLYMORPHISM OF ARSENIC.
K.Plieth and I.N.Stranski.
Z. Phys., Vol. 156, No. 3, 360-81 (1959). In German.

The importance of molecular structure in determining the kinetics of phase transformations is pointed out by comparing the vaporization, condensation, fusion and solution processes in the cubic and monoclinic forms of arsenic trioxide.

B.T.M.Willis

Defect Properties

539.2

2816 A METHOD OF EXPERIMENTALLY DETERMINING THE BURGERS VECTOR OF STABLE DISLOCATIONS IN CUBIC BODY-CENTRED CRYSTALS. B.Šesták.
Czech. J. Phys., Vol. 8, No. 6, 741-2 (1958).

Groups of edge dislocations are chosen which form simple symmetrical boundaries, and their intersections with (112) and (110) planes calculated. The calculated values agree with results obtained from etch pit measurements. J.Franks

539.2

2817 THE DEFORMATION OF A WHISKER WITH AN EDGE DISLOCATION. F.Kroupa.
Czech. J. Phys., Vol. 9, No. 3, 332-8 (1959). In Russian.

An approximate solution is given of the deformation of a plate caused by an edge dislocation lying in the central plane. The results are used to discuss the bending of a whisker as a result of an edge dislocation; in the calculations the whisker is approximated as an infinite band.

539.2

2818 ON THE MECHANISM OF RENDERING VISIBLE DISLOCATIONS ON THE SURFACE OF [ALPHA] IRON CRYSTALS BY ANODIC DISSOLVING. B.Šesták.
Czech. J. Phys., Vol. 9, No. 3, 339-47 (1959).

The influence of the crystallographic orientation of the surface is investigated, the effect of carbon is confirmed and the anodic process is studied. The mechanism of dissolving the crystal is given and a suitable method of rendering dislocations visible is derived.

539.2

2819 SELF-ENERGY OF A HELICAL DISLOCATION. R.De Wit.
Phys. Rev., Vol. 116, No. 3, 592-7 (Nov. 1, 1959).

Kröner's energy expression [Ergebrisse der angewandte Mathematik, Vol. 5 (1958) p.78] is used in this theoretical calculation. The helical dislocation is assumed to have a uniform shape with the Burgers vector along its axis. The axial length of the helix is large compared to its radius and the radius is large compared to the dislocation "cross-section", which is of the order of a Burgers vector. For a helix of many turns and arbitrary pitch an expansion in a Fourier cosine series is used. The self-energy is found in terms of elementary functions and Kapteyn series of Bessel functions. In the limiting cases of a tightly wound helix (small pitch) and a nearly straight helix (large pitch) simple expressions result, which have a plausible physical explanation. For a tightly wound helix the dominant term represents the contribution from the cylindrical part of the helix, the first-order terms represent the influence of the size of the dislocation cross-section and the second-order terms represent the effect of the axial component of the helix. For the nearly straight helix the dominant terms represent the contribution from the straight screw part and the second-order terms are taken to give the interaction between the turns of the helix. Finally the correction in the self-energy when a return loop is present is considered.

539.2

2820 THEORY OF DISPLACEMENT CASCADES IN COMPOUNDS. E.M.Baroody.
Phys. Rev., Vol. 116, No. 6, 1418-24 (Dec. 15, 1959).

When a solid is exposed to certain high-energy radiations, moving atoms are produced which distribute energy among other atoms in an expanding chain of collisions, thus eventually displacing

many atoms from their original sites. One of the tasks of the theory of irradiation effects is to relate this disordered state to the nature and velocity of the primary atom and to the properties of the crystalline lattice. The theory undertakes the determination, for a simple model, of functions $N_{jk}(T)$ which represent the numbers of atoms of various kinds displaced when a primary atom received an energy T. Assuming isotropic collisions involving pairs of free atoms, differential equations are formulated which contain concentrations, collision cross-sections and mass ratios as parameters. Binding of the atoms is introduced through initial conditions which define threshold energies for displacement. Assuming a single threshold, linear equations for Laplace transforms are obtained and used to study the high-energy behaviour of the functions. The effect of separate thresholds for the various kinds of atoms is examined for the case of equal masses. Detailed calculations for diatomic solids indicate that cascades of moderate energy are rather well described by the high-energy equations and that the total number of displaced atoms is insensitive to mass ratio. Consideration of a monatomic solid with a spectrum of thresholds shows that such a solid should behave as though it possesses a single sharp threshold slightly below the mean of the spectrum.

539.2

2821 DISLOCATION INTERACTIONS IN FACE-CENTRED CUBIC METALS, WITH PARTICULAR REFERENCE TO STAINLESS STEEL. M.J.Whelan.

Proc. Roy. Soc. A, Vol. 249, 114-37 (Jan. 1, 1959).

Experiments by transmission electron microscopy on thin foils of stainless steel have enabled the interaction of dislocations on different slip systems to be observed in detail. Interactions are most frequently observed in piled-up groups as a result of attractions between the piled-up dislocations and isolated dislocations on other systems. The combination of dislocations takes place over short lengths only, leading to the formation of short segments of the resultant dislocation and of networks. The interactions are first discussed theoretically in terms of undissociated dislocations and then in terms of ribbon dislocations. Various configurations of the interacting ribbons are derived corresponding to the possible combinations of Burgers vectors which lead to attraction. Interesting features are found to occur at the nodes of the interacting and resultant dislocations; some nodes are contracted, others are extended into wide regions of fault. In some cases the structures of nodes have been resolved, so that direct comparison with theory can be made. The agreement between theory and observations verifies the dislocation theory in fine detail; the concepts of stair-rod dislocations and Lomer–Cottrell interactions all appear to be well founded. Other deductions from the observations include an estimate of stacking-fault energy from an extended node, and the probable non-existence of extrinsic faults. The factors determining the lengths over which the interactions take place are also briefly considered.

539.2

2822 NEUTRON AND FISSION FRAGMENT DAMAGE IN ZIRCONIA. J.Adam and B.Cox.

Phys. Rev. Letters, Vol.3, No.12, 543-4 (Dec. 15, 1959).

The irradiation-induced phase transformation observed in natural zirconia does not take place in pure, synthetic zirconia exposed to neutrons. The transformation in natural zirconia is ascribed to the presence of uranium impurity, and experiments are described showing that the principal role of the uranium is as a stabilizing agent rather than as a source of fission fragments, which accelerate the transformation. B.T.M.Willis

539.2

2823 COLOR CENTERS IN CADMIUM FLUORIDE. M.Rubenstein and E.Banks.

J. Electrochem. Soc., Vol. 106, No. 5, 404-9 (May, 1959).

Single crystals of CdF_2, purified and containing additions of NaF, CeF_3, and equimolar quantities of NaF and CeF_3, were grown from the melt in graphite crucibles in a helium atmosphere. Physical constants of CdF_2 were measured. Optical transmission spectra were obtained before and after X-irradiation on slices of single crystals (about 1.5 mm thick), at 28°, −78°, −190°C. Crystals containing 0.05-4 mole % NaF, when irradiated at 28° or at −78°C, showed a radiation-induced absorption near the fundamental absorption edge; this induced absorption is stable at 28°C. These same crystals, when irradiated at −190°C, showed another absorption which is unstable at −78°C. CdF_2, pure, and containing low concentrations of CeF_3, NaF, or equimolar CeF_3 and NaF, all showed one X-ray induced absorption band, unstable above −10°C. CdF_2 X-irradiated at room temperature showed a very stable absorption band.

539.2

2824 X-RAY EXPANSION AND COLORATION OF UNDOPED AND IMPURITY-DOPED NaCl CRYSTALS. H.Rabin.

Phys. Rev., Vol. 116, No. 6, 1381-9 (Dec. 15, 1959).

Expansion and coloration measurements of undoped and imp impurity-doped single crystals of NaCl were made under X-ray irradiation (43 kVp and 20 mA) for intervals up to 3 hr. Expansion was measured in a direction normal to the X-ray beam with a sensitive capacitive dilatometer that was designed to compensate automatically for thermal fluctuations. It was found that the initial rate of creation of F centres exceeds the rate of creation of vacancy pairs as computed from the expansion data; however, after continued irradiation the rates of F-centre and vacancy-pair production are approximately evenly matched. This suggests that the initial production of F centres results from both vacancies originally contained in the crystal and vacancies created during irradiation, while the later coloration is due essentially to vacancies that are created in the irradiation process. Within the framework of this interpretation it is possible to estimate the initial negative-ion vacancy concentration of a number of crystals. This concentration ranges from $1 \times 10^{16}/cm^3$ for a Harshaw crystal to a value larger than $6 \times 10^{17}/cm^3$ for a calcium-doped crystal grown in the laboratory. Although the prescence of a large initial concentration of negative-ion vacancies in calcium-doped NaCl explains its enhanced colour sensitivity to X-rays without a corresponding enhancement of X-ray-induced expansion, this explanation is not in accord with simple expectations of charge compensation and the law of mass action.

539.2

2825 STRUCTURE OF V CENTERS IN IRRADIATED $KClO_3$. T.E.Hasty, W.B.Ard, Jr and W.G.Moulton.

Phys. Rev., Vol. 116, No. 6, 1459-63 (Dec. 15, 1959).

On the basis of the electron spin resonance spectra of a single crystal of $KClO_3$ which was exposed to X-irradiation, a model is proposed for the V centre produced. The centre proposed consists of a ClO radical covalently bonded to a neighbouring ClO_3^- ion. It is shown that the e.s.r. spectra predicted for this radical agrees with the observed spectra, both in the number and spacing of the hyperfine components and their orientation dependence in the external magnetic field. It is also proposed that an O_3^- centre is produced rather than the usual F centre which one might expect to accompany the V centre.

539.2

2826 SELF-DIFFUSION IN POLYCRYSTALLINE NICKEL. J.R.MacEwan, J.U.MacEwan and L.Yaffe.

Canad. J. Chem., Vol. 37, No. 10, 1623-8 (Oct., 1959).

The self-diffusion of nickel has been studied in polycrystalline samples by a sectioning technique. There is evidence of grain boundary diffusion below temperatures of 1150°C. The results obtained between 1150° and 1400°C are representative of volume diffusion and are represented by the expression

$$D = 3.36 \exp(-69\,800/RT).$$

A comparison is made with the results of other self-diffusion studies using Zener's hypothesis.

539.2

2827 DIFFUSION OF Ni^{63} IN IRON, COBALT, NICKEL, AND TWO IRON–NICKEL ALLOYS. J.R.MacEwan, J.U.MacEwan and L.Yaffe.

Canad. J. Chem., Vol. 37, No. 10, 1629-36 (Oct., 1959).

The self-diffusion of nickel and the diffusion of Ni^{63} into iron, cobalt, and two iron–nickel alloys was studied using the technique of decrease in surface activity. The nickel self-diffusion results are compared to previously reported values. Nickel is found to diffuse more slowly than iron in the iron-rich portion of the iron–nickel system. The rate of nickel diffusion increase with increasing nickel content. A comparison is made between the present results for diffusion of Ni^{63} into iron, cobalt, and nickel with reported values for diffusion of Co^{60} and Fe^{59} in the same metals. In each solvent, the magnitudes of the activation energies, Q, are such that $Q_{Ni} > Q_{Co} > Q_{Fe}$.

539.2

2828 THE EFFECT OF PLASTIC [COMPRESSIVE] DEFORMATION ON SELF-DIFFUSION IN SILVER.
A.F.Forestieri and L.A.Girifalco.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 99-105 (July, 1959).

The self-diffusion coefficient was measured from 810° to 1172°K and at strain rates from 0.00075 to 0.006 hr^{-1}. At all temperatures it was found that the diffusion coefficient is proportional to the strain rate. The results were interpreted on the basis of a model in which two vacancy-production mechanisms and two vacancy-annealing mechanisms are assumed to be operative. At low temperatures, vacancy production is assumed to occur by a geometric, temperature-independent process, and the annealing mechanism is assumed to be the migration of vacancies to fixed sinks. At high temperatures, it is suggested that vacancies are formed by a thermally activated process and that they anneal by combining with a highly mobile defect. Energy considerations lead to the conclusion that this mobile defect is probably a divacancy.

539.2

2829 THE DIFFUSION INTO GERMANIUM CRYSTALS CONTAINING A GRAIN BOUNDARY. F.Karstensen.
Z. Naturforsch., Vol. 14a, No. 12, 1031-9 (Dec., 1959). In German.

The diffusion of donor and acceptor impurities along small angle grain boundaries in germanium is investigated using the position of a p–n junction to mark the distance to which the impurity has diffused. A much faster diffusion along the "dislocation pipes" is observed than is usually found for volume diffusion in nearly perfect material. The diffusion coefficient for As and Sb may be as much as 10^3-10^6 times greater than the normal value.

C.A.Hogarth

539.2

2830 BEHAVIOR OF InSb SURFACES DURING HEAT TREATMENT. D.Haneman.
J. appl. Phys., Vol. 31, No. 1, 217-18 (Jan., 1960).

When InSb crystals were heated to about 400°C, small flat-topped hillocks formed on the surface. They travelled over the surface at velocities up to 20μ/s when the heating rate was a few °C/min. Possibly Sb evaporates preferentially, leaving In-rich regions which melt at about 400°C and become mobile. R.C.Kell

539.2

2831 LOW-TEMPERATURE IRRADIATION OF TRANSITION METALS IN AN ATOMIC PILE. P.Lucasson.
Ann. Phys. (Paris), Ser. 13, Vol. 4, No. 3-4, 435-88 (March-April, 1959). In French.

A series of transition metals was irradiated at or near the temperature of liquid N in the heavy water pile E.L.2 at Saclay. Measurements of electrical resistance in situ were used to compare the changes in resistivity produced by a given number of atomic displacements. Resistance measurements were also employed to study fluctuations in the pile power. J.Thewlis

539.2 : 536.21

2832 THE EFFECT OF FAST NEUTRON BOMBARDMENT ON THE THERMAL CONDUCTIVITY OF SILICA GLASS AT LOW TEMPERATURE. J.H.Crawford, Jr and A.F.Cohen.
Bull. Inst. Internat. Froid, Annexe 1958-1, 165-72.

Silica glass shows an increase in density which saturates at about 3% for exposures 5×10^{19} neutrons/cm^2. This "phase" which is lacking in long-range order is also produced in quartz, tridymite and cristobalite. A twofold increase in thermal conductivity at 5°K was also found as expected and both effects are annealed out after 9 hr at 925°C. An explanation involving the effective phonon relaxation length is discussed. J.E.Caffyn

539.2

2833 A CONTRIBUTION TO THE STUDY OF THE THERMAL PROPERTIES OF NaCl:Ca CRYSTALS IRRADIATED WITH X-RAYS. J.Trnka.
Czech. J. Phys., Vol. 8, No. 6, 749 (1958).

The results are given of measuring the temperature differences of coloured (irradiated with X-rays) and non-coloured crystals of NaCl with different concentrations of Ca, when they were heated at a uniform rate. The coloured crystals heated by radiation more rapidly than the non-coloured ones. B.T.M.Willis

539.2

2834 RADIATION EFFECTS IN SILICA AT LOW TEMPERATURES. G.W.Arnold and W.D.Compton.
Phys. Rev., Vol. 116, No. 4, 802-11 (Nov. 15, 1959).

Optical absorption bands induced in fused silica crystalline α-quartz of low impurity content at 77°K by fast electrons or X-rays bleach slowly at room temperature. The presence of OH^- ions in fused silica inhibits the formation of such radiation-induced absorption. Comparison of the number of centres produced at 215 mμ (C band) in Corning 7943 fused silica (OH^- free) for equal absorbed dose when irradiated with electrons and X-rays indicates that displacements are not involved in the initial formation of the colour centres. A defect model requiring simple ionization seems adequate to explain most of the observed phenomena in this pure fused silica. No simple model can be proposed which adequately describes the data in the case of the Corning 7940 fused silica (OH^- bearing).

539.2

2835 NATURE OF DEFECTS ARISING FROM FAST NEUTRON IRRADIATION OF SILICON SINGLE CRYSTALS. R.Truell.
Phys. Rev., Vol. 116, No. 4, 890-2 (Nov. 15, 1959).

A method is described for determining the range of sizes that damaged regions created by fast neutrons may have in a silicon single crystal. In particular the use of precision ultrasonic velocity and attenuation measurements for compressional waves together with certain new results from scattering theory permit the determination of an upper and lower limit on the size of a damaged region. The lower limit is determined from the fractional velocity change arising from the irradiation and the upper limit is found from the corresponding attenuation change — or in this case the lack of it. Under the assumption that such regions of damage are spherical the limits obtained lie in a range from 0.01 to 0.27 μ for the radius of the region.

539.2

2836 LOW-TEMPERATURE ANNEALING OF IRRADIATION-INDUCED DEFECTS IN LiF.
D.A.Wiegand and R.Smoluchowski.
Phys. Rev., Vol. 116, No. 5, 1069-80 (Dec. 1, 1959).

The expansion of alkali halides due to X-ray irradiation was observed at 90° and 300°K. Simultaneous measurements of the F-band indicate that the expansion can be roughly explained on the basis of the generation of negative ion vacancies. However, partial annealing of the expansion of LiF at approximately 130°K after irradiation at 90°K is not accompanied by a decrease in the density of negative ion vacancies associated with F-centres, therefore indicating that the expansion cannot be completely due to the increase in the density of F-centres. The low-temperature annealing of the expansion can be associated with either vacancy pair diffusion or interstitial motion. While experiments with plastic deformation and M-band formation in LiF argue against vacancy pair diffusion, the spin resonance experiments of Känzig and Woodruff (Abstr. 2654 of 1958) support the interstitial interpretation. It is therefore tentatively concluded that halogen vacancy interstitial pairs are generated by X-ray irradiation in LiF at 90°K and that the low-temperature annealing is due to a change in interstitial configuration.

539.2

2837 KINETICS OF ISOTHERMAL ANNEALING OF RADIATION DAMAGE IN SZILARD–CHALMERS REACTION WITH COBALT COMPLEXES. I. TRIS-ACETYLACETONE COBALT (III)—SECTION 1.
A.Nath, K.S.Venkateswarlu and J.Shankar.
Proc. Indian Acad. Sci. A, Vol. 46, No. 1, 29-52 (July, 1957).

Isothermal annealing has been found to follow first-order kinetics for the range of temperature studied. It has been found that the previous thermal history is reflected in the rate-constant (k) and the plot of log k versus 1/T exhibits a marked curvature. This has been explained as due to the fact that the annealing reaction leading to the parent specie is not a simple unimolecular one but is complex, involving several stages which in turn exercise mutual influence on other competing reactions preventing annealing. During an isothermal anneal, the fate of the metastable specie is decided by three competitive reactions—one for annealing to the parent specie and the other two working in the reverse direction—the existence of which have been shown by graphical analysis of experimental data. One of the latter processes seem to be amenable to reversal in the sense that more metastable specie becomes available for anneal at a higher temperature after a run to infinity at a lower one. It seems

that this process consists of "setting" or "trapping" of the metastable specie with variable depths—a physical process which inhibits at the particular temperature, the annealing of the metastable specie. Considerable experimental work would be required to elucidate unambiguously the nature of the damage centre but the indications are that it is of a "configurational" or "electronic" nature, as it is amenable to both "thermal" as well as "radiation" annealing.

539.2

2838 BORDONI RELAXATION — A CRITIQUE OF DONTH'S THEORY. J.Lothe.
Z. Phys., Vol. 157, No. 4, 457-61 (1960). In German.

By elementary reasoning one would expect an activation energy $W \cong 2W_k$ for the Bordoni peak where W_k is the kink energy This assumption fits experimental evidence. It is pointed out that in the Donth theory (Abstr. 1342 of 1958) for the Bordoni peak, the radiation loss from the dislocation oscillators is overestimated and that a recalculation of the Donth theory will probably yield an activation energy $W \cong 2W_k$.

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

539.2 : 537.3

2839 STUDY OF THE INFLUENCE OF VERY SMALL QUANTITIES OF IMPURITIES ON THE CHANGE AT LOW TEMPERATURES OF THE ELECTRICAL RESISTANCE OF COLD-WORKED ALUMINIUM. O.Dimitrov and P.Albert.
Bull. Inst. Internat. Froid, Annexe 1958-1, 219-30. In French.

Gives the results of resistivity measurements on high purity aluminium cold-worked at the temperature of liquid nitrogen and annealed at low temperatures (−40° to −80° C). The results were correlated with micrographic studies of the specimens. Two types of recovery are shown to occur: one associated with recrystallization (supported by X-ray diffraction) and a second whose cause is not clear. E.G.Knowles

539.2 : 537.3

2840 THE APPLICATION OF GREEN FUNCTIONS TO THE QUANTUM THEORY OF THE ELECTRICAL CONDUCTIVITY OF METALS. A.N.Voloshinskii.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 4, 655-7 (1959). In Russian.

Theories of transport phenomena based on the Block theory of electron–phonon interactions do not agree well with experiment at low temperatures. The author shows how Green functions may give better agreement and as an example calculates the temperature variation of the resistivity of a metal near 0° K and the remanent resistivity. Agreement with experimental results for Na is good. A.F.Brown

539.2 : 537.3

2841 TEMPERATURE DEPENDENCE OF MAGNETORESISTANCE COEFFICIENTS IN SILICON-IRON. H.Kimura and E.Tatsumoto.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 113-22 (April, 1959).

Concerning the temperature dependence of the magnetoresistance coefficients κ_1 and κ_2, observations have been made on 3.83% silicon-iron crystals from liquid air temperature up to the Curie point, as part of a systematic programme of the same research on iron, silicon-iron, aluminium-iron, some of which have already been published. Addition of small amounts of silicon to iron appears to change the signs of both κ_1 and κ_2 at low temperatures and to remove a minimum of the κ_1 versus temperature curve around 500° C. As a possible origin of these effects, it is suspected that a few valence electrons of the silicon transfer to the iron, so that the non-spherical Fermi surface may deform further.

539.2 : 537.3

2842 QUANTUM THEORY OF TRANSVERSE GALVANOMAGNETIC PHENOMENA. E.N.Adams and T.D.Holstein.
J. Phys. Chem. Solids, Vol. 10, No. 4, 254-76 (Aug., 1959).

A theory of electrical conduction in crossed electric and magnetic fields is given for the limit of very weak scattering. A density matrix formulation of the problem is used, and an arbitrary scattering mechanism is considered. The theory is found to be completely equivalent to theories given earlier by Titerica (1935) and by Davydov and Pomeranchuk (1940). Formulae are given for the resistivity in the quantum limit for both longitudinal and transverse orientations of electric field, for degenerate and non-degenerate statistics, and for several different scattering mechanisms. The oscillatory conductivity is calculated for acoustical and ionized-impurity scattering mechanisms. Formulae obtained for the quantum transport effects are in disagreement with the formulae of Lifshits (Abstr. 5930 of 1958) and of Argyres (Abstr. 5931 of 1958). The discrepancy is attributed to unwarranted approximations in those authors' treatments of scattering.

539.2 : 537.3

2843 ELECTRICAL RESISTIVITY OF YTTRIUM SINGLE CRYSTALS. P.M.Hall, S.Legvold and F.H.Spedding.
Phys. Rev., Vol. 116, No. 6, 1446-7 (Dec. 15, 1959).

Two samples of yttrium cut from the same single crystal were used to determine the electrical resistivity parallel and perpendicular to the c-axis of the hexagonal close-packed metal. Measurements were made over the temperature range from 1.3 to 300° K. A large anisotropy was observed, with $\rho_\perp/\rho_\parallel = 2.1$ at room temperature. Values for the polycrystalline resistivity over the temperature range indicated were computed from these data and were found to fit a Grüneisen law with $\theta = 187.5°$ K. The computed polycrystalline values were also in good agreement with the measured resistivity of a polycrystalline sample.

539.2 : 537.3

2844 THEORY OF THE RESISTANCE MINIMUM IN DILUTE PARAMAGNETIC ALLOYS.
A.D.Brailsford and A.W.Overhauser.
Phys. Rev. Letters, Vol. 3, No. 7, 331-2 (Oct. 1, 1959).

A temperature-dependent contribution $\Delta\rho$ to the resistivity of a dilute solid solution of paramagnetic ions is obtained by considering the s-d exchange scattering of a conduction electron by nearest-neighbour pairs of ions. A scattering centre with closely spaced energy states is produced by the interaction $-WS_1.S_2$ between the members of the ion-pair. S_1, S_2 are the spin operators for the ions and W is an exchange integral. The scattering cross-sections are different for the different energy states and the occupancy of these states, and the available final states into which the electron can be inelastically scattered, depend on the temperature. It is shown that the interference between the scattered waves from the two atoms of a pair is such that the contribution $\Delta\rho_{el.}$, from the elastic scattering predominates over the contribution from the inelastic scattering. If the interaction of an ion-pair is ferromagnetic ($W > 0$), $\Delta\rho_{el.}$ is increasing with decreasing temperature such that $W/kT < 1$. Thus $\Delta\rho$ increases with decreasing temperature in this region and competition with the decreasing phonon resistivity produces the resistance minimum, the size of which is proportional to the number of pairs per cm^3. The resistance will also go through a maximum at a lower temperature unless a given inequality is satisfied. R.B.Stinchcombe

539.2 : 537.3

2845 RESISTANCE MINIMUM AND RESISTIVITY OF COPPER AT LOW TEMPERATURES. S.T.Sekula.
Phys. Rev. Letters, Vol. 3, No. 9, 416-18 (Nov. 1, 1959).

These preliminary results show that annealing copper in a reducing atmosphere can increase the resistivity and create a resistance minimum at low temperatures. Annealing in an oxidizing atmosphere both reduces the resistivity and removes the minimum. The phenomena appear to be reversible. M.G.Priestley

539.2 : 537.3

2846 ON THE INFLUENCE OF DOMAIN STRUCTURE ON THE ELECTRICAL RESISTANCE OF IRON AT LOW TEMPERATURES. A.M.Sudovtsov and E.E.Semenenko.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 305-7 (July, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 1, 211-12 (Jan., 1959).

The contribution to the resistance due to scattering of electrons by the domain boundaries was studied by magnetoresistance experiments at temperatures varying from room to liquid-helium temperature. If the temperature is low enough for the mean free path to approach the dimensions of the domains, the (longitudinal) resistance drops with increasing field, due to the disappearance of boundaries, and also to the alignment of the magnetic moments of the various domains. The ordinary galvanomagnetic effect dominates in a transverse field. L.Pincherle

539.2 : 537.3

2847 THE INFLUENCE OF PLASTIC DEFORMATION ON THE ANOMALOUS BEHAVIOUR OF THE RESISTANCE OF GOLD AT LOW TEMPERATURES.

N.E.Alekseevskii and Yu.P.Gaidukov.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 804-6 (Sept., 1958).

In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 558-9 (March, 1959).

The minimum in the temperature dependence of the electrical resistance and the value H_c of the magnetic field at which the minimum disappears were found to depend strongly on deformation. At a certain deformation the minimum disappears and H_c tends to infinity. After annealing the initial conditions are restored. The temperature at which the minimum occurs (~ 4-6°K) is not altered by deformation. All these results confirm that the resistance minimum is connected with the scattering of the conduction electrons by impurities. L.Pincherle

539.2 : 537.3

2848 GALVANOMAGNETIC EFFECTS IN METALS WITH NEARLY EQUAL NUMBERS OF ELECTRONS AND HOLES. M.I.Kaganov and V.G.Peschanskii.

Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1052-3 (Oct., 1958).

In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 4, 734 (April, 1959).

Simple formulae are derived for the resistivity and the Hall coefficient as functions of the magnetic field and for the difference between the electron and hole densities. L.Pincherle

539.2 : 537.3

2849 INVESTIGATION OF THE ELECTRICAL CONDUCTIVITY OF ZINC OXIDE. J.Dereń, J.Haber and T.Wilkowa.

Z. Phys., Vol. 155, No. 4, 453-64 (1959). In German.

The variation of conductivity σ of polycrystalline specimens from 100 to 700°C at different pressures is investigated in order to clarify the mechanism of the irreversible change of σ with temperature. The experimental results show that this is dependent on the state of equilibrium of chemisorbed layers of O_2 on the surface of the ZnO and complies with the thermal activation of donor atoms. A model to explain the growth of the ZnO lattice by diffusion of interstitial Zn^{++} ions in the direction of the surface is proposed. G.C.Williams

539.2 : 537.3 : 537.52

2850 POSSIBLE EXPLANATION OF THE CURRENT DENSITY-DEPENDENT RESISTIVITY OF EXPLODING WIRES.

T.J.Tucker.

J. appl. Phys., Vol. 30, No. 11, 1841-2 (Nov., 1959).

Refers to initial current densities in gold wires of 10^7 - 10^8 A/cm^2. The resistivity is dependent on current density, and passes through a maximum for varying circuit energies. It is suggested that this is due to the formation of arcs shunting the wire when the latter is in a pre-vaporized liquid state. J.D.Craggs

539.2 : 537.3 : 539.219

2851 SPECIFIC ELECTRICAL CONDUCTANCE OF ALLOYS OF THE SYSTEM Al—Zn AND ITS PHASE DIAGRAM.

O.Pečijare.

Annu. Fac. Phil. Skopje, Sect. Sci. Nat., Vol. 10, 63-71 (1957).

In Macedonian.

Alloys with up to 31.6 wt% Zn show an almost linear conductance—temperature dependence, with a slight discontinuity at 100°C (when the α phase begins to increase at the cost of the β phase); with >31.6 wt% Zn, the alloys show a slight singularity at 100°C and a more pronounced one (an inflexion) at 275°C. At room temperature, the conductance of alloys with >25 wt% Zn practically does not depend on the concentration of Zn and is nearly equal to the conductance of that element. F.Lachman

Semiconductors

539.2 : 537.311

2852 THE MEASUREMENT OF CONDUCTIVITY IN SEMI-CONDUCTORS WITH THE AID OF MICROWAVES.

T.Stubb.

Acta polytech. Scand., PH2 (No. 259/1959) 14 pp = State Inst. Tech. Res., Finland Publ., No. 47, 14 pp (1959).

A contactless method of measuring the conductivity of semiconductors, in the range 0.1 to 200 (ohm cm)$^{-1}$, at microwave frequencies, that takes into account the effect of impurity and lattice scattering, is described. Results for a 10 ohm cm disk of p-type single crystal of Si in the 3 cm band are given. An accuracy of 10% is claimed. G.C.Williams

539.2 : 537.311

2853 A NEW METHOD OF MEASURING THE MAGNETO-CALORIC EFFECT IN FERROMAGNETIC SEMI-CONDUCTORS. K.Závěta.

Czech. J. Phys., Vol. 8, No. 6, 727-31 (1958). In Russian.

The application of the normal method of measuring the magneto-caloric effect by means of a thermocouple, results in considerable errors due to thermal losses in the thermocouple when used for poor thermal conducting materials such as ceramic ferromagnetics. In the case of such materials, it is possible to make use of the high value of the relative temperature change of resistance R^{-1} dR/dT, which involves the whole of the sample volume. This method has been used for manganese ferrite with an excess of manganese. A curve of the temperature variation of the magnetocaloric effect is obtained, and the sensitivity of measurement is considered to be sufficient for low field observations in ferrimagnetics. K.N.R.Taylor

539.2 : 537.311

2854 MEASUREMENT OF THE HALL COEFFICIENT AND ELECTRICAL CONDUCTIVITY IN SEMI-CONDUCTORS BY THE METHOD OF AN ALTERNATING MAGNETIC FIELD AND ALTERNATING CURRENT. J.Dušek.

Czech. J. Phys., Vol. 9, No. 2, 250-5 (1959).

A description is given of equipment which enables the simultaneous measurement of the Hall coefficient and the electrical conductivity. The instrument is adapted for measuring a minimum Hall coefficient of 3×10^{-11} Vcm/AG and electrical resistance from 10^{-3} to 10^3 ohm; the smallest measurable Hall voltage is 1 μV. Deviations from the results obtained by the conventional d.c. method do not exceed 5%.

539.2 : 537.311

2855 MEASUREMENT OF THE SPECIFIC RESISTANCE OF SEMICONDUCTOR CRYSTALS USING HIGH FREQUENCY. W.Keller.

Z. angew. Phys., Vol. 11, No. 9, 346-50 (Sept., 1959). In German.

The method described avoids direct contact with the rod-shaped silicon crystals, which may be wrapped in a protective foil. Capacitative coupling to a tuned circuit is used, the circuit damping being a measure of crystal resistance. A calibration by means of crystals of known resistivity is necessary. K.W.Plessner

539.2 : 537.311 : 621.317.73

2856 IMPROVED AUTOMATIC FOUR-POINT RESISTIVITY PROBE. D.Dew-Hughes, A.H.Jones and G.E.Brock.

Rev. sci. Instrum., Vol. 30, No. 10, 920-2 (Oct., 1959).

This continuously recording instrument is a most rapid and convenient means for determining the resistivity profile, and hence the distribution of net extrinsic conduction centres along the length, of a polycrystalline bar or single crystal of semiconductor material. It is the only method available for determining the quality of such material within a very short time of its preparation, and thus is important as a quality-control tool in any semiconductor crystal growing operation. It is severely limited by three factors: (1) it is only a surface measurement, (2) it gives no information about the degree of compensation existing in the material, and (3) it cannot detect the presence of electrically inactive impurities. When combined with more complete characterization of samples cut from a few discrete points along the crystal, it is invaluable as a means of interpolation between these discrete points.

539.2 : 537.311 : 621.382 : 621.317.61

2857 THE DARK-SPOT METHOD FOR MEASURING THE DIFFUSION CONSTANT AND LENGTH OF EXCESS CHARGE CARRIERS IN SEMICONDUCTORS. A.C.Sim.

Proc. Instn Elect. Engrs, Paper 2997E [Convention on Transistors and Associated Semiconductor Devices] Vol. 106B, Suppl. No. 15, 34-28 (1959).

The well known basic method of measuring diffusion length, introduced by Goucher, is here applied in its optimum form. This consists in illuminating the semiconductor surface with interrupted light of uniform intensity and casting a circular shadow whose diameter can be varied. A detector is placed at the centre of the shadow and the variation of signal with the shadow radius can be

interpreted theoretically with high precision. The method possesses advantages of circular symmetry, maximum signal strength, simplicity of optical apparatus, and speed of operation. The same apparatus may be employed to measure the diffusion coefficient by using repeated impulses of light, the results giving an exponential law independent of surface recombination. Full experimental details and discussions are given, together with a complete mathematical theory which takes into account surface recombination, penetration of photons, boundary effects and shadow effects, and gives a method of measuring the rate of change of diffusion length across the sample surface. A number of experimental results are presented with a tabulated function for their interpretation.

539.2 : 537.311

2858 MANY-ELECTRON THEORY OF THE HOLE BAND IN DIAMOND-TYPE CRYSTALS. E.I.Kaplunova.
Fiz. tverdogo Tela, Vol. 1, No. 2, 177-85 (Feb., 1959). In Russian.

A diamond-type crystal with one electron removed is discussed. The wave-function of a perfect crystal is constructed in the form of an antisymmetric product of ϕ-functions of individual σ-bonds; to represent a hole, one of the σ-bond functions is replaced by a one-electron function. A crystal with a mobile hole is represented by a linear combination of such functions. The energy of the system is found as a function of the wave-vector k with allowance for hole transitions between the first and the second nearest bonds. Two heavy-hole and one light-hole bands are obtained which are adjacent at $k = 0$. Parameters in the theoretical expressions are found by comparing the theory with experimental data on germanium and silicon.

A.Tybulewicz

539.2 : 537.311

2859 ACCURATE THEORY OF RECOMBINATION IN A PLASMA. V.L.Bonch-Bruevich.
Fiz. tverdogo Tela, Vol. 1, No. 7, 1076-83 (July, 1959). In Russian.

Considers the capture of electrons in a semiconductor. The process is regarded as an electronic transition due to a perturbation by a quantized plasma wave. The corresponding transition probability is derived by standard formulae. In order to evaluate the result various models for the field of force of the bound electron (electron-trap) are employed. Coefficients of recombination are derived, the result is discussed but there is no direct comparison with measurements.

R.Eisenschitz

539.2 : 537.311

2860 ON THE THEORY OF ELECTRON PLASMAS IN SEMICONDUCTORS.
V.L.Bonch-Bruevich and Sh.M.Kogan.
Fiz. tverdogo Tela, Vol. 1, No. 8, 1221-4 (Aug., 1959). In Russian.

A discussion of the Green's functions for an electron gas at finite temperatures is given. An expression for the plasma frequency and the dispersion of the plasma mode is derived, and this agrees with earlier results. The screened potential is calculated both for distances greater than the thermal wavelength, where the Debye formula is obtained, and for distances much less than the thermal wavelength, where the potential is

$$\phi(r) = \frac{Ze}{r}\ \exp(-\alpha r)\cos(\alpha r)\ ;\ \alpha = \sqrt{2}\left(\frac{\pi n m e^2}{\epsilon h^2}\right)^{\frac{1}{4}}$$

D.J.Thouless

539.2 : 537.311

2861 APPLICATION OF THE MAGNETOCONCENTRATION EFFECT TO THE INVESTIGATION OF THE SURFACES OF SEMICONDUCTORS. V.P.Zhuze, G.E.Pikus and O.V.Sorokin.
Fiz. tverdogo Tela, Vol. 1, No. 9, 1420-30 (Sept., 1959). In Russian.

The method of determining the velocity of surface recombination by measuring the resistance of a semiconductor was applied to the investigation of the energy structure of the surface of germanium, i.e. the energies of the so-called fast states and their distribution. The new method was based on the relation between the resistance of a thin, flat specimen in a magnetic field, and the difference between the velocities of surface recombination on its two large faces. Results are given for germanium n and p, treated with etchant CP-4, and are in good agreement with those obtained by other methods. For the magnetoconcentration effect, see Abstr. 8775 (1956).

N.Davy

539.2 : 537.311

2862 THE INFLUENCE OF THE SPACE CHARGE OF MOBILE CARRIERS ON THE ELECTRICAL BREAKDOWN OF A HIGHLY ASYMMETRICAL P–N JUNCTION. A.I.Uvarov.
Fiz. tverdogo Tela, Vol. 1, No. 9, 1457-9 (Sept., 1959). In Russian.

It is usually assumed that the low-resistance region does not affect the rectifying properties, in particular the breakdown voltage. For an asymmetrical p–n junction the carriers diffuse to the high-resistance side and their concentration can be greater than the concentration of ionized impurities, thereby changing the potential distribution, so that the low-resistance part of the junction affects the breakdown voltage. Calculation shows that for germanium with $N_a \sim 10^{16}$ cm^{-3} (N_a is the acceptor density) the correction to the breakdown voltage is less than 1%.

R.Berman

539.2 : 537.311

2863 A SIMPLIFIED THEORY OF TWO-CARRIER, SPACE-CHARGE-LIMITED CURRENT FLOW IN SOLIDS. M.A.Lampert.
R.C.A.Rev., Vol. 20, No. 4, 682-701 (Dec., 1959).

Two-carrier, space-charge-limited current flow is analysed by an extension of the method introduced by Rose (Abstr.4645 of 1955), to treat the one-carrier problem. The analysis is carried out for those situations where most of the injected carriers and their concomitant space charge are free, and where the currents are field-driven. The analysis does not require specific assumptions about the dependence of carrier drift velocities on field intensity. Results are obtained for both monomolecular and bimolecular recombination. Where exact theoretical results are available (see, for example, Abstr.13279 of 1959), the present, simplified theory checks remarkably well.

539.2 : 537.311

2864 RATE OF DIFFUSION-LIMITED ANNIHILATION OF EXCESS VACANCIES.
Philips Res. Rep., Vol. 14, No. 4, 337-45 (Oct., 1959).

The rate of removal and the spatial distribution of excess vacancies are calculated for the case where the transport to vacancy sinks takes place by diffusion and where dislocations in the volume of the sample, the surface of the sample, or both, may act as sinks. The medium in which the diffusion takes place is considered to be a continuum. It is found that in the case where the dislocations are the only sinks, the decay in average concentration is exponential. The decay time constant is almost inversely proportional to the dislocation density. In the case where the surface is the only sink an appreciable deviation from an exponential decrease in average concentration does occur in the beginning of the removal process. In a bar of square cross-section the contribution of the two types of sink is about equal if a few tens of dislocations emerge through the smallest cross-section.

539.2 : 537.311

2865 PHOTOCONDUCTIVE AND PHOTOELECTROMAGNETIC LIFETIME DETERMINATION IN PRESENCE OF TRAPPING. I. SMALL SIGNALS. A.Amith.
Phys. Rev., Vol. 116, No. 4, 793-802 (Nov. 15, 1959).

Impurities which are located in the forbidden energy gap of a semiconductor are classified as traps or as recombination and generation levels, according to their capture cross-sections and their proximity to the quasi-Fermi levels of the carriers. Their influence upon the photoconductance and the photoelectromagnetic effect is considered; noted in particular are their effects on the values of carrier lifetimes deduced from these photosignals. The lifetimes deduced are always too high for that type carrier of which some are trapped, and they are too small for the other type carrier. In extrinsic material the photoeffects are augmented by trapping of minority carriers, and diminished by trapping of majority carriers. In general the effects of minority carrier trapping are more severe than those of majority carrier trapping. Furthermore, the photoelectromagnetic effect is much less sensitive to trapping than is the photoconductance and may often yield the correct minority carrier lifetime in extrinsic material. Consequently, the method of deducing carrier lifetimes by combining the photoconductance and the photoelectromagnetic effects may lead to very misleading results indeed. Yet separate measurements of the two effects over a range of temperatures will yield the carrier lifetimes, the energy level of the traps, and their density. Moreover, concomitant measurements of the spectral dependence of photoconductance and the photoelectromagnetic effect in an extrinsic semiconductor would serve to classify the impurity centres which are found, because an impurity photoelectromagnetic effect occurs only if the carriers generated from the centres are minority carriers.

539.2 : 537.311

2866 PHOTO-PIEZOELECTRIC EFFECT IN SEMICONDUCTORS. J.Tauc and M.Závětová.
Czech. J. Phys., Vol. 9, No. 5, 572-7 (1959).

A new photovoltaic effect was observed, which is caused by inhomogeneous distribution of the pressure in a semiconductor. Its production can be explained by the dependence of the energy gap on the pressure.

539.2 : 537.311

2867 CORRELATION ENERGY IN A MODEL SEMICONDUCTOR. J. Callaway.
Phys. Rev., Vol. 116, No. 6, 1368-71 (Dec. 15, 1959).

The correlation energy of the electrons in a semiconductor is expected to be less than in a metal with the same electron density. The reduction occurs because the existence of an energy gap between filled and empty states tends to increase the magnitude of the energy denominators of perturbation theory. This effect is studied in a simple model, based on the calculations of Gell-Mann and Brueckner (Abstr.6372 of 1957), in which the semiconductor is represented as a free electron gas with an energy gap above the Fermi surface. The correlation energy then depends on the ratio of the energy gap to the valence bandwidth as well as on the density. It is shown that for an energy gap large compared with the bandwidth, second order perturbation theory is correct; while for a small energy gap, an explicit correction to the Gell-Mann–Brueckner series can be obtained.

539.2 : 537.311

2868 LATTICE SCREENING IN POLAR SEMICONDUCTORS. S.Doniach.
Proc. Phys. Soc., Vol. 73, Pt 6, 849-55 (June, 1959).

The influence of space charge screening on electron–phonon scattering in a polar semiconductor is discussed. Owing to the high optical mode frequency the polarization of conduction electron space charge, by the lattice, must be treated in a dynamic way. In the limit of long lattice waves the classical Drude formula may be used, suggesting that the space charge polarization may lead to the enhancement of electron-optical mode phonon scattering probabilities, as opposed to the near static screening effect occurring for acoustic mode phonons. A calculation is made of the detailed wave number and frequency dependence of the space charge polarization by the lattice, using a self-consistent field approximation. At low temperatures, and for fairly low conduction electron concentrations, the Drude type enhancement is confirmed.

539.2 : 537.311

2869 AUGER EFFECT IN SEMICONDUCTORS. A.R.Beattie and P.T.Landsberg.
Proc. Roy. Soc. A, Vol. 249, 16-29 (Jan. 1, 1959).

This paper presents a calculation of the lifetimes (τ) of excess electrons and holes in a semiconductor assuming the Auger effect between bands (electron-electron and hole-hole collisions) to be the only recombination mechanism. If pair annihilation, and the corresponding reverse process of pair creation, are counted separately, there are four classes of processes to be considered. The suitably weighted algebraic sum of the rates of these processes yields a net recombination rate R. If N be the non-equilibrium number of pairs, then $\tau = N/R$. In the calculation the effect of traps is neglected, and the group of electrons in the conduction band and the group in the valence band are each assumed to be in equilibrium among themselves, but not with each other, by the use of quasi-Fermi levels. The theory is compared with experimental lifetimes in InSb, and shows that the mechanism envisaged may dominate radiative recombination above 240°K and accounts for the order of magnitude of the observed lifetimes ($\sim 10^{-6}$ s) in the neighbourhood of the highest temperature (330°K) at which recombination in InSb has so far been studied.

539.2 : 537.311

2870 MINORITY CARRIER INJECTION AND EXTRACTION PHENOMENA IN A NEARLY INTRINSIC SEMICONDUCTOR. R.Boite.
Rev. H.F., Vol. 4, No. 7, 151-6 (1959). In French.

Expressions are obtained, neglecting diffusion effects, for the time required for the attainment of the steady state after the application of a current step to a filament through an injecting contact, for the steady-state current through a filament with an extracting contact and for the time for the attainment of the latter current after the sudden establishment of a steady minority-carrier density at the contact less than the bulk equilibrium density.

F.F.Roberts

539.2 : 537.311

2871 SOLID STATE DEVICES. I.J.Richmond.
Research, Vol. 12, No. 10-11, 374-80 (Oct.-Nov., 1959).

Review, particularly of devices using InSb.

539.2 : 537.311 : 538.56

USE OF CYCLOTRON RESONANCE IN SEMICONDUCTORS FOR THE AMPLIFICATION AND GENERATION OF MICROWAVES.
See Abstr. 2437

539.2 : 537.311

2872 THE PROBLEM OF STUDYING THE MOBILITY OF COPPER IONS IN GERMANIUM. A.Ya.Potemkin, V.I.Potapov and D.A.Petrov.
Dokl. Akad. Nauk. SSSR, Vol. 127, No. 6, 1256-8 (Aug. 21, 1959). In Russian.

The transport of copper in ~20 ohm cm n-type Ge at 500–680°C was studied, with applied fields of ~1 V/cm, using a potential probe method of following the diffusion front. At 540° the mobility of the Cu^+ ion was $4{\cdot}2 \times 10^{-5}$ and at 650° 7×10^{-6} cm²/V sec; the corresponding diffusion constants were $2{\cdot}9 \times 10^{-6}$ and $5{\cdot}5 \times 10^{-6}$ cm²/sec with an activation energy of 4·9 kcal/mole. See also Abstr. 2428 of 1954; Abstr. 8427 of 1956. C.H.L.Goodman

539.2 : 537.311

2873 AN INVESTIGATION OF THE INTERACTION OF HOLES IN p-TYPE GERMANIUM WITH ACOUSTICAL BRANCH VIBRATIONS. I.V.Mochan, Yu.N.Obraztsov and T.V.Smirnova.
Fiz. tverdogo Tela, Vol. 1, No. 9, 1351-9 (Sept., 1959). In Russian.

The temperature dependence of the phonon contribution to thermoelectric power of germanium, α_ϕ, and its change in a magnetic field are measured. From these results and those of other authors it is found that $\alpha_\phi \sim \bar{\tau}_\phi/\bar{\tau}_h T \sim T^{-0.3}$ for n- and p-type germanium (T is the absolute temperature). The temperature variation of $\bar{\tau}_h$, the relaxation time for holes due to one-phonon scattering processes with longitudinal waves in p-type-germanium, is close to the predicted $\bar{\tau}_h \sim T^{-1.5}$. The relaxation time for phonons due to interaction with electrons is given by $\bar{\tau}_\phi \sim T^{-0.7}$ between ~ 50 and 200°K. The temperature dependence of the hole mobility requires some scattering mechanism other than acoustic waves; this may be scattering by the optical branch. R.Berman

539.2 : 537.311

2874 THE NATURE OF SURFACE RECOMBINATION CENTRES IN GERMANIUM. A.V.Rzhanov, Yu.F.Novototski-Vlasov and I.G.Neizvestny.
Fiz. tverdogo Tela, Vol. 1, No. 9, 1471-4 (Sept., 1959). In Russian.

The surface recombination velocity (s) was measured as a function of the temperature T, (300°< T < 475°K) for 20-25 ohm.cm p-type Ge specimens and found to vary as $s \propto \exp(-0.2\,eV/kT)$, saturating for T > 400°K. The proposed model is that, as a result of oxide solution etching, germanium oxide forms at the surface structural defects ($\sim 10^{13}$ cm^{-2}) and that these recombination centres are deactivated during the presence of water molecules.

D.J.Huntley

539.2 : 537.311

2875 VISIBLE LIGHT FROM A GERMANIUM REVERSE BIASED p-n JUNCTION. J.T.Nelson and J.C.Irvin.
J. appl. Phys., Vol. 30, No. 11, 1847 (Nov., 1959).

The junction was the emitter of a diffused base transistor made by alloying with aluminium. Light has been observed for surface concentration between 10^{17} cm^{-3} and 10^{18} cm^{-3}. It is tentatively suggested that the radiation arises from the recombination of hot electrons and holes in an avalanche breakdown. D.J.Oliver

539.2 : 537.311

2876 ON THE DELAYED YIELD IN GERMANIUM AND INDIUM ANTIMONIDE. D.Dew-Hughes and G.E.Brock.
J. appl. Phys., Vol. 30, No. 12, 2020-1 (Dec., 1959).

The meagre published data on the delay time for plastic yielding in germanium and indium antimonide can be interpreted by Cottrell's theory. Reasonable values are deduced for the binding energy between a dislocation and a single impurity atom. B.T.M.Willis

539.2 : 537.311

2877 THERMAL OSCILLATIONS IN n-GERMANIUM AT LOW TEMPERATURE. S.H.Koenig and R.D.Brown III.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 201-3 (July, 1959).

The low-temperature breakdown in germanium is shown to be unstable under certain circumstances. The instability occurs when a small increase in current in part of the sample produces a local temperature rise which cannot be dissipated before it in turn causes a further current increase. The instability generally results in thermal relaxation oscillations of the sample with associated electrical relaxation oscillations of the measuring circuitry. The oscillations cause an effective negative resistance to appear when d.c. measurements are made in the usual manner.

539.2 : 537.311

2878 ELECTRONIC SURFACE STATES AND THE CLEANED GERMANIUM SURFACE. P.Handler and W.M.Portnoy.
Phys. Rev., Vol. 116, No. 3, 516-26 (Nov. 1, 1959).

The large p-type surface conductivity and field-induced surface conductivity of the cleaned germanium surface were measured over the temperature range 77°-300° K. It was found that the surface conductivity and the field-induced surface conductivity are almost independent of temperature, varying by a factor of two over the temperature range investigated. The effect of oxygen, atomic hydrogen, and water vapour on the surface conductivity was also observed. A qualitative two-dimensional band model is presented which correlates most of the experimental results. In this model, which is somewhat similar to the three-dimensional band model of graphite, there is a two-dimensional surface state band at the surface which overlaps in energy a two-dimensional valence band just beneath the surface. The states which form the surface state band are assumed to be perturbed out of the conduction band. The filling of these surface states with electrons out of the valence band gives rise to the observed p-type conductivity associated with the cleaned germanium surface. The states perturbed out of the conduction band are shown to be associated with the unfilled orbitals of the germanium surface atoms. A second system, where a similar two-dimensional matrix of unfilled orbitals is found, is in the dislocations associated with medium-angle grain boundaries. It is shown that the transport properties of these grain boundaries are similar in magnitude and temperature dependence to that observed for the clean germanium surface. The same model presented for the surface can be used to explain the transport properties of grain boundaries.

539.2 : 537.311

2879 INFLUENCE OF DEGENERACY ON RECOMBINATION RADIATION IN GERMANIUM. J.I.Pankove.
Phys. Rev. Letters, Vol. 4, No. 1, 20-1 (Jan. 1, 1960).

The emission spectrum, at 77° K, of a tunnel diode was measured for various currents through the diode. Two maxima were observed, one saturating with increasing current and moving from about 0.6 to about 0.65 eV, the other, at 0.71 eV, growing rapidly. A tentative interpretation is given in terms of a broad impurity band partly overlapping the bottom of the conduction band. L.Pincherle

539.2 : 537.311

2880 OBSERVATION OF DIRECT TUNNELING IN GERMANIUM. J.V.Morgan and E.O.Kane.
Phys. Rev. Letters, Vol.3, No.10, 466-8 (Nov. 15, 1959).

In a Ge diode under conditions of reverse bias there is the possibility of electrons tunnelling from the top of the valence band at $k = 0$ to the conduction band minimum at $k = 0$ directly, without the assistance of any perturbing mechanism. The onset of this direct tunnelling was in fact observed at a reverse bias of about 0.14 V as a very significant increase in tunnelling current. From the I-V characteristics and reasonable assumptions the energy difference between the conduction band minimum at $k = 0$ and the lowest minimum was calculated as 0.13 eV, a somewhat smaller value than given by magneto-optical experiments. There is some evidence from the curves that impurity scattering is important in determining their shape, particularly for P- and As-doped junctions. L.Pincherle

539.2 : 537.311

2881 OSCILLATION OF THE ELECTRICAL RESISTANCE OF N-TYPE GERMANIUM IN STRONG PULSED MAGNETIC FIELDS. I.G.Fakidov and É.A.Zavadskii.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1036-7 (April, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 716-17 (Oct., 1958).

The effect was observed in a piece of single crystals germanium (ρ at 300° K was 54 Ω cm) at 20° K. The magnetoresistance was negative for this sample and showed oscillation with a period of 0.18 kG^{-1}. D.J.Oliver

539.2 : 537.311

2882 TEMPERATURE DEPENDENCE OF THE CONDUCTIVITY OF AMORPHOUS GERMANIUM EVAPORATED LAYERS. H.Richter and R.Schneider.
Z. angew. Phys., Vol. 11, No. 7, 277-83 (July, 1959). In German.

Measurements made, in high vacuo, from 20 to 600° C, show the conductivity to have three distinct phases; (1) disordered layer conduction which is strongly dependent on the pre-treatment of the layers: both the activation energy, which varies from 0.25 eV to 0.65 eV, and the resistivity are dependent on the degree of disorder; (2) single conduction: the activation energy is 0.90 eV where the annealing at temperature causes evaporation of impurities and ordering of the structure (Abstr. 6297 of 1959); (3) transformation of amorphous Ge to crystalline Ge occurs at a well defined temperature (~300° C) when evaporation of impurities, which impeded crystal growth at a lower temperature, occurs. The activation energy of "transformed" Ge is 0.75 eV in agreement with values for crystalline Ge. The mechanism of conduction is considered in terms of oxidation of Ge layers and lattice parameters. G.C.Williams

539.2 : 537.311

2883 THE EFFECTIVE CONTACT AREA OF POINT CONTACT CRYSTAL RECTIFIERS. E.Groschwitz and R.Ebhardt.
Z. angew. Phys., Vol. 11, No. 9, 342-6 (Sept., 1959). In German.

It is known that in diodes using n-type Ge as the bulk semiconductor there exists a p-type surface layer of high conductivity, not only under the formed contact area, but extending outward to the base electrode. The contribution of this inversion layer to the current flow, both in the forward and reverse directions is calculated. It is found that a voltage-dependent effective radius of the inversion layer can be derived, which defines an extension of the contact junction area. K.W.Plessner

539.2 : 537.311

2884 INVESTIGATION OF THE SEMICONDUCTING PROPERTIES OF THE Si–Mn SYSTEM. E.N.Nikitin.
Fiz. tverdogo Tela, Vol. 1, No. 2, 340-3 (Feb., 1959). In Russian.

Electrical conductivity and thermo-e.m.f. were measured, and the temperature dependence of these properties was determined. Maximum values of the studied properties were observed in the phases with the highest degree of order, and the results indicated that Mn and Si form alloys characterized by metallic bonds. M.H.Sloboda

539.2 : 537.311

2885 THE TEMPERATURE DEPENDENCE OF THE LOW-LEVEL LIFETIME AND CONDUCTIVITY MOBILITY OF CARRIERS IN SILICON. D.M.Evans.
J. Electronics and Control, Vol. 7, No. 2, 112-22 (Aug., 1959).

The temperature dependence of the low-level lifetime in silicon has been found to be consistent with that expected from the theory based on a low level of injection, a low density of recombination centres and a single energy level for the recombination centres. The temperature dependence of the conductivity mobility has also been determined.

539.2 : 537.311

2886 SURFACE RECOMBINATION OF SILICON. H.U.Harten.
Philips Res. Rep., Vol. 14, No. 4, 346-60 (Oct., 1959).

The surface recombination velocity of electrons and holes in silicon is investigated by measuring the photovoltaic effect of a p–n junction alloyed on a thin silicon wafer. The method has been reported previously; its principle is explained here on the basis of a hypothetical experiment. It appears from measurements that after treating the surface with an aqueous solution of potassium dichromate the recombination is lowered by ozone in the ambient atmosphere and raised by moisture. The opposite behaviour is observed after etching with hydrofluoric acid. In principle there is no difference in the behaviour of n-type and p-type silicon. In many cases the surface recombination can be decreased with light, particularly if the surface treatment tends to form an inversion layer. The observations can be interpreted by the assumption that the surface recombination on silicon is due to recombination centres and therefore influenced by the position of the Fermi level at the surface, and that an additional influence is due to the voltage across the surface barrier layer.

539.2 : 537.311

2887 RECOMBINATION RADIATION FROM HOT ELECTRONS IN SILICON. L.W.Davies.
Phys. Rev. Letters, Vol. 4, No. 1, 11-12 (Jan. 1, 1960).

Reports measurements, at 77° K, of the spectral distribution of the recombination radiation from p- weakly p–n silicon structures biased in the forward direction with (pulse) current densities up to 10^4 amp/cm^2. Since no broadening of the recombination spectrum is observed other than the small amount associated with Joule heating, one may conclude that excitons are formed and that the spectral distribution is determined by the energy distribution of the excitons, which corresponds to the lattice temperature.

L.Pincherle

539.2 : 537.311 : 621.317.3 : 621.382

2888 MEASUREMENT OF LIFETIMES IN SILICON. V.Husa and J.Kříž.

Slaboproudy Obzor, Vol. 20, No. 10, 615–17 (1959). In Czech.

The method is based on the principle of photocurrent modulation. The sample is illuminated transversely by means of short pulses (100μs) of infrared radiation. The change in current flowing through the sample (when illuminated by the pulse) is used to determine lifetime. The pulses are produced by a small rotating mirror which interrupts a focused beam derived from a Silit rod heated by a current of 16A. The method was compared with the cavity-resonator method and its accuracy was found to be satisfactory. The main advantages of the method are its simplicity and comparatively high sensitivity.

R.S.Sidorowicz

539.2 : 537.311 : 537.533

ELECTRON EMISSION FROM SILICON p–n JUNCTIONS. See Abstr. 2376

539.2 : 537.311

2889 EFFECT OF AGEING ON THE ELECTRICAL PROPERTIES OF THE SEMICONDUCTING SYSTEM Bi_2Te_3–Bi_2Se_3. L.Štourač.

Czech. J. Phys., Vol. 9, No. 6, 717–20 (1959). In Russian.

It is shown that the change in electrical conductivity and thermoelectric force are caused by the change in concentration of the free electrons. The effect of this process on the efficiency of equipment employing the Peltier effect is analysed.

539.2 : 537.311

2890 THE MECHANISM OF THE SCATTERING OF CARRIERS IN CERTAIN SOLID SOLUTIONS BASED ON THE TELLURIDES OF LEAD AND BISMUTH. B.A.Efimova, T.S.Stavitskaya, L.S.Stil'bans and L.M.Sysoeva.

Fiz. tverdogo Tela, Vol. 1, No. 9, 1325–32 (Sept., 1959). In Russian.

Variation of electron and hole mobilities with concentration is given for the systems Bi_2Te_3–Sb_2Te_3, Bi_2Te_3–Bi_2S_3, PbTe–PbSe, Bi_2Te_3–Bi_2Se_3 and PbTe–SnTe; from these it is deduced that the electrons and holes move essentially in a sublattice of cations and anions, respectively. In the last three of the above systems, the dependence of mean free time (τ) for scattering at neutral impurities is determined as a function of the temperature (T) and carrier energy (E) from mobility measurements. For the T dependence specimens with a degenerate electron gas were used and in all cases it was found that $\tau \propto T^{-1}$. The energy dependence was found to vary from $E^{-0.4}$ to $E^{-0.8}$ by using non-degenerate specimens.

D.J.Huntley

539.2 : 537.311

2891 INVESTIGATION OF THE SYMMETRY OF THE ENERGY BANDS OF ELECTRONS IN CRYSTALS OF THE TYPE $CdIn_2Se_4$. A.I.Gubanov and F.M.Gashimzade.

Fiz. tverdogo Tela, Vol. 1, No. 9, 1411–16 (Sept., 1959). In Russian.

The methods of group theory have been used to investigate the energy spectrum of electrons in semiconductors of the type $CdIn_2Se_4$, which crystallize in lattice space group D^1_{4d} and tetragonal syngony. Account is taken of spin–orbital resonance and comparison made with lattices of the sphalerite type.

W.Bardsley

539.2 : 537.311 : 621.382

2892 A CdS ANALOG DIODE AND TRIODE. W.Ruppel and R.W.Smith.

R.C.A. Rev., Vol. 20, No. 4, 702–14 (Dec., 1959).

An ideal insulator represents the "electrical analogue" of a vacuum since it is devoid of free charge carriers. Space-charge-limited excess carriers can be drawn through an insulator across an ohmic contact which provides the reservoir of excess carriers. Diode and triode operation that is precisely analogous to the corresponding vacuum devices is obtained by applying ohmic and blocking contacts to the insulator. Analogue diode and triode operation is demonstrated using an insulating CdS single crystal.

539.2 : 537.311

2893 PHASE EQUILIBRIA AND SEMICONDUCTING PROPERTIES OF CADMIUM TELLURIDE. D.deNobel.

Philips Res. Rep., Vol.14, No.4, 361–3 (Aug.), 430–41 (Oct., 1959).

In this thesis the relation is studied between the electrical and optical properties of single crystals of cadmium telluride and the conditions of preparation. The p-T-x diagram of the system cadmium–tellurium is described, showing the temperatures and Cd pressures of the maximum melting point and the melting point of stoichiometric CdTe. The compound is purified by zone refining; foreign atoms are incorporated by zone levelling and single crystals are grown, which are reheated at various Cd pressures between 700° and 1000° C, followed by quenching to room temperature. On these samples conductivity and Hall measurements are performed at various temperatures, which lead to values of the concentration of charge carriers, of the ionization energies of the various centres and — for n-type samples with shallow donors — of the density of state effective mass of the free electrons ($m_n^*/m = 0.14 \pm 0.04$). Thermo-electromotive force measurements of various n and p-type samples lead to values of the same effective mass for both types of carrier, depending on the value adopted for the transport energy of electrons and holes ($m_n^*/m = 0.13 - 0.066$; $m_p^*/m = 0.41 - 0.22$). From a hydrogen-like model for the shallow donor an inertial effective mass for the electrons of $(m_n^*)_i = 0.147$ is obtained. From optical transmission measurements at various temperatures a value for the band gap of 1.50 eV at room temperature and a temperature dependence of 2.34×10^{-4} to 5.44×10^{-4} eV/°K is found. Peaks in the spectra of photoluminescence and photoconductivity can be correlated with band-band transition and with transitions between levels, caused by known centres, and one of the bands. A theoretical discussion is presented of the various equilibria which determine the state of CdTe at high temperature. By assuming a certain band scheme and values for the equilibrium constants, it is possible to calculate the concentrations of charge carriers and centres at room temperature as a function of the Cd pressure at which the crystals were reheated. A qualitative comparison between the experimental and various theoretical diagrams leads to the adoption of a definite band scheme, in which two levels are ascribed to the cadmium vacancy and one to interstitial cadmium, to indium (as a specific donor) and to gold (as a specific acceptor), respectively. From a quantitative discussion of the diagrams the values of some equilibrium constants are obtained, viz. the Frenkel constant K_F and the reduction constant K_r, describing the equilibrium crystal–vapour. The temperature dependence of these constants leads to the energies required for the atomic processes involved. Finally, the association effects which take place during the quenching of activated samples are analyzed. In the appendix a discussion is given of the type of bonding in CdTe.

539.2 : 537.311

2894 EXPERIMENTAL INVESTIGATION OF CONDUCTION BAND OF GaSb. A.Sagar.

Phys. Rev., Vol. 117, No. 1, 93–100 (Jan. 1, 1960).

The conduction band of GaSb was investigated by making the following measurements on a number of n-type samples with different carrier concentrations: (1) Hall effect and conductivity between 1.5° and 370° K; (2) the change of resistance and Hall effect of the samples under hydrostatic pressure (up to 14×10^9 dynes/cm^2) at room temperature; and (3) the change of resistance due to uniaxial stress between 77° and 370° K. The data can be explained on the basis of a double conduction band for this material with the lowest band-minimum in the centre of the Brillouin zone characterized by spherical constant-energy surfaces and the next minima along [111] directions in k-space characterized by ellipsoidal constant-energy surfaces. The data can be further interpreted by assuming that the deformation potentials for the two bands in GaSb are similar to those of the corresponding bands in n-type germanium. The energy separation of the two bands at room temperature is estimated to be about 0.08 eV. The observed temperature dependence of the piezoresistance could be explained by assuming that the energy separation ΔE changes with temperature at a rate $(d\Delta E/dT) \approx -3 \times 10^{-4}$ eV/° C. Throughout the analysis, the relaxation times for the electrons in the two bands were assumed to be independent of energy.

539.2 : 537.311 : 621.382.23

2895 GALLIUM-ARSENIDE DIFFUSED DIODES. J.Lowen and R.H.Rediker.

J. Electrochem. Soc., Vol. 107, No. 1, 26–9 (Jan., 1960).

GaAs has been used to fabricate variable reactance and com-

puter diodes which compare favourably with the best commercially available of germanium and silicon. The diodes have been fabricated by zinc diffusion into n-type GaAs. Ohmic contact to the n-type material has been made with an Sb–Au alloy and to the p-type side with indium. Etching is used to remove the p-type diffused skin from everywhere but under the indium contact, thereby forming the mesa and defining the p–n junction area. Rectification ratios (at 2 V) as high as 10^{10} have been achieved. The diodes have been operated successfully in a variable reactance amplifier at S-band (2800 Mc/s) and in millimicrosecond-switching computer circuits.

539.2 : 537.311 : 621.382.232

2896 GaAs TUNNEL DIODES.
R.Gremmelmaier and H.J.Henkel.
Z. Naturforsch., Vol. 14a, No. 12, 1072-3 (Dec., 1959). In German

The higher energy gap and low effective mass mean that tunnel diodes can probably be made with improved properties when GaAs is used in preference to other semiconductors. The characteristics of three such diodes made by alloying tin onto p-type GaAs are given at room temperature and at 450 and 100°K. The useful characteristic is improved by cooling. C.A.Hogarth

539.2 : 537.311

2897 THERMAL, ELECTRICAL AND OPTICAL PROPERTIES OF (In,Ga)As ALLOYS.
M.S.Abrahams, R.Braunstein and F.D.Rosi.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 204-10 (July, 1959).

The (In,Ga)As system exhibits complete solid miscibility. Homogeneous alloys were produced across the entire system by using the method of zone-levelling. Physical measurements show that the lattice thermal conductivity decreases markedly with alloying and exhibits a minimum value of about 0.05 $W deg^{-1} cm^{-1}$ at an alloying composition of about 50 per cent. The thermoelectric power varies linearly with the logarithm of the carrier concentration for non-degenerate crystals, and from these data it appears that the "density of states mass" is independent of alloying. The mobility of electrons decreases monotonically with increasing percentages, up to about 70 per cent of GaAs. The band gap varies continuously with composition, and a concave upward dependence is observed on going from InAs to GaAs.

539.2 : 537.311

2898 PREPARATION AND SOME PROPERTIES OF INDIUM SULPHIDE SINGLE CRYSTALS. G.Syrbe and C.Kleint.
Z. Naturforsch., Vol. 14a, No. 8, 754 (Aug., 1959). In German.

The conductivity, at room temperature, of needle-shaped single crystals of In_2S_3, several mm in length and between 5-30 μ in cross-section, lies in the range 1-100 $(\Omega\ cm)^{-1}$. The voltage–current characteristic and the influence of irradiation on conductivity are examined. G.C.Williams

539.2 : 537.311

2899 ELECTRICAL CONDUCTIVITY OF SINGLE CRYSTALS OF MgO. S.P.Mitoff.
J. chem. Phys., Vol. 31, No. 5, 1261-9 (Nov., 1959).

The electrical conductivity of magnesium oxide at temperatures in the region of 1300°C is observed to depend upon the partial pressure of oxygen surrounding the sample. The conductivity increases at oxygen pressures both higher and lower than 10^{-4} atmospheres. At this pressure the conductivity is a minimum. This effect is increased as the iron content is increased and is almost absent in the purest samples. The conductivity is electronic rather than ionic and the number of charge carriers is controlled by the number of lattice vacancies. The dependence of conductivity on oxygen pressure may be satisfactorily explained by changes in stoichiometry and thus lattice defects in magnesium oxide. These changes in stoichiometry are larger when the magnesium oxide is contaminated with a variable valence impurity like iron than when it is pure. If an explanation based on iron changing valence state is accepted, then it may be demonstrated by an analysis of the chemical equilibria involved that anion deficiencies must appear at low oxygen pressures, cation deficiencies at high oxygen pressures, and that all defects must lie close to the variable valence impurity ions.

539.2 : 537.311

2900 ELECTRICAL PROPERTIES AND STRUCTURE OF COMPLEX OXIDE SEMICONDUCTORS.
I. MnO–CuO–CoO–O_2 SYSTEM.
I.T.Sheftel', A.I.Zaslavskii, E.V.Kurlina and G.N.Tekster-Proskuryakova.
Fiz. tverdogo Tela, Vol. 1, No. 2, 227-41 (Feb., 1959). In Russian.

The electrical conductivity σ and the electron activation energy ΔE were measured as a function of composition. These properties and the constant A in

$$\sigma = A \exp(-\Delta E/2kT)$$

were found to be practically independent of composition. This was due to the constancy of the spinel structure of the main crystal phase. The electrical properties were found to depend primarily on the Mn component whose ions occupy predominantly octahedral positions in the spinel lattice, while Cu and Co cations occupy tetrahedral vacancies. A.Tybulewicz

539.2 : 537.311

2901 INVESTIGATION OF THE SEMICONDUCTOR/ELECTROLYTE PHASE BOUNDARY SURFACE IN THE SYSTEM SELENIUM/SULPHURIC ACID.
H.Gobrecht, R.Kuhnkies and A.Tausend.
Z.Elektrochem., Vol. 63, No. 5, 541-50 (1959). In German.

A noteworthy change in the potential/current-density relationship is caused by the variation of concentration of the charge carrier on the surface of an electrode. Both p-Se and n-Se of various conductances were used, the constancy (in time) of the charge carriers being attained by using different impurities in the Se-electrode and different proportions of these impurities. It is also possible to vary the concentration of the charge carriers on the surface by illumination; the magnitude of the transition overpotential can be calculated from the pure semiconductor data. F.Lachman

539.2 : 537.311 : 539.217

2902 STUDY OF THE PROPERTIES OF THE SYSTEM $AgSbTe_2$–PbTe. H.Rodot.
C.R. Acad. Sci. (Paris), Vol. 249, No. 19, 1872-4 (Nov. 9, 1959). In French.

Up to 40% PbTe, the alloys are solid solutions of cubic structure (NaCl type). For higher proportions two phases exist. For the solid solutions the lattice spacing is greater than for pure $AgSbTe_2$ and the melting points are lower. The electrical properties are investigated and the potentialities of the materials for thermoelectric devices are discussed. C.A.Hogarth

539.2 : 537.311

2903 THE QUESTION OF THE INVERSION OF THE CONDUCTIVITY TYPE OF THE SEMICONDUCTING SYSTEM $Zn_xCd_{1-x}Sb$. K.Šmirous and L.Štourač.
Z. Naturforsch., Vol. 14a, No. 12, 1073-4 (Dec., 1959). In German.

Previous work on this material, where $0 < x < 1$, has shown that conduction is always p-type. If a small proportion of Te is alloyed with a compound of composition $Zn_{0.15}Cd_{0.85}Sb$ the sign of thermoelectric power changes from plus to minus at some fixed temperature which varies with the relative antimony content. C.A.Hogarth

539.2 : 537.311

2904 THERMOELECTRIC STUDIES ON $Zn_xCd_{1-x}Sb$.
E.Justi, G.Neumann and G.Schneider.
Z. Phys., Vol. 156, No. 3, 217-34 (1959). In German.

From consideration of the equilibrium diagram Zn–Sb and some further experiments, it is deduced that previous work on ZnSb must have dealt with mixtures of several phases. The heat treatment necessary to produce a single phase of ZnSb or its solid solutions with CdSb (up to 30 at.%) is determined. The resulting material shows much higher values of thermoelectric power than the mixed phase solids. Electrical and thermal conductivities and Hall effect are measured as a function of Cd content, while thermo-e.m.f. is determined over a range of temperatures. By doping with Cu or Sn the conductivity is increased until a maximum value of the figure of merit "z", in relation to thermoelectric power generation, is reached. This value is 0.001. K.W.Plessner

Photoconductivity

539.2 : 537.312

2905 THE QUANTUM EFFICIENCY OF THE INTERNAL PHOTO-ELECTRIC EFFECT IN INDIUM ANTIMONIDE.
J.Tauc and A.Abrahám.

Czech. J. Phys., Vol. 9, No. 1, 95-100 (1959).

A method is described for measuring the relative quantum efficiency in semiconductors by simultaneously measuring the photomagnetoelectric and photoconductive effect. The results of measurements on indium antimonide are given. The quantum efficiency begins to increase if the energy of the photon exceeds 0.47 eV at room temperature. The quantum efficiency as a function of the energy of the photon is analysed on the basis of the conception of impact ionization and it is shown that a study of the structure of this curve can supply information on the band structure of a semiconductor in the region of high energies of electrons and holes.

539.2 : 537.312

2906 A.C. IMPEDANCE MEASUREMENTS ON INSULATED CdS CRYSTALS.

H.Kallmann, B.Kramer and G.M.Spruch.
Phys. Rev., Vol.116, No.3, 628-32 (Nov. 1, 1959).

In order to study the induced conductivity in CdS crystals without charge injection at the electrodes, the crystals were insulated with Mylar and a.c. impedance measurements were made. The capacitance and resistance of the crystals were studied as functions of intensity and wavelength of excitation, and frequency and voltage of the a.c. field. The crystal–Mylar combination was found to behave in a manner similar to that of powdered samples in like experiments. With a model that treats the crystal as a capacitor shunted by a light-sensitive resistance, the capacitance was found to increase with intensity of excitation, and to decrease with voltage and frequency. The resistance of the crystal increased by factors of 4 or 5 as the intensity of excitation decreased by factors of 10. The limitations of the model are discussed and conclusions drawn regarding whether trapped electrons or only conduction electrons contribute to the impedance.

539.2 : 537.312

2907 EFFECTS OF POLARIZED LIGHT ON PHOTOCURRENTS AND PHOTOVOLTAGES IN ZnS.

G.Cheroff, R.C.Enck and S.P.Keller.
Phys. Rev., Vol. 116, No. 5, 1091-3 (Dec. 1, 1959).

The anomalous short-circuit photocurrents in ZnS were measured using polarized light. In spite of the fact that, for a given wavelength, light polarized perpendicular to the c-axis is more strongly absorbed than light polarized parallel to the c-axis, there are wavelength regions in which the absolute magnitude of the short-circuit photocurrents are smaller for perpendicularly polarized light. The data are consistent with a double valence band model.

539.2 : 537.312

2908 THE ACHIEVEMENT OF MAXIMUM PHOTOCONDUCTIVITY PERFORMANCE IN CADMIUM SULFIDE CRYSTALS. R.H.Bube and L.A.Barton.
R.C.A. Rev., Vol.20, No.4, 564-98 (Dec., 1959).

Improved photoconductivity performance (i.e. gain × speed) requires a decrease in trapping centre concentration, probably by several orders of magnitude, over that currently available in commercial materials. The incorporation of compensating impurities acts to increase the imperfection concentration. An investigation was made, therefore, of other methods of producing sensitive crystals. These include : (1) producing slight deviations from stoichiometry during growth; (2) incorporating a trace of donor impurity; (3) annealing conducting crystals in sulphur vapour; (4) resubliming pure crystals under a variety of conditions. Photosensitive crystals prepared by all of these methods are discussed, and it is found that a number of crystals prepared by the first and second of these methods show marked improvement in performance over standard photoconductors. Between trap depths of 0.2 and 0.7 eV, such crystals have a trap density in the range of 10^{13} cm^{-3}. For operating conditions at room temperature, the trap density near the Fermi is at least an order of magnitude less than this density. Improvements in low-light performance by factors of 10^3, and maximum-gain (M) factors as high as 500 have been observed. Almost all crystals prepared by the third and fourth methods show low speed of response at room temperature because of the presence of traps with depth of about 0.6 eV and density of 10^{14} to 10^{15} cm^{-3}.

539.2 : 537.312

2909 THE SLOW RESPONSE OF SELENIUM BARRIER-LAYER PHOTOELEMENTS. F.König.
Z. angew. Phys., Vol. 11, No. 11, 418-28 (Nov., 1959). In German.

Performance is measured of some 16 different photocells under dark conditions, with "d.c." or with intermittent light excitation and under open circuit or shunted conditions. The l.f. response shows slow relaxation effects, but at higher frequencies a Schottky barrier type model with no charge diffusion gives good agreement with the experimental data. G.F.J.Garlick

539.2 : 537.312

2910 THE INFRARED QUENCHING OF THE PHOTOCONDUCTIVITY OF CdS SINGLE CRYSTALS.

J.Auth, E.A.Niekisch and H.Puff.
Z. phys. Chem. (Leipzig), Vol. 212, No. 3-4,175-204 (1959). In German.

The infrared quenching spectra of photoconductivity between room temperature and liquid hydrogen temperature were obtained for pure CdS single crystals, and crystals doped with Mn, Sn, Cu and Ag. The quenching spectra consisted of two bands at 0.85–0.9 and 1.2-1.5 eV, the short wave band generally persisted down to 21°K, whereas the long wave band often disappeared at about 200°K. The general quenching properties were not greatly dependent on the doping of the crystals, but differences in detailed behaviour were observed. It is concluded that two classes of recombination centres exist, one of the classes consisting of a level at about 0.2 eV and one or two further levels at 1.1-1.2 eV above the valence band. J.Franks

539.2 : 537.312 : 621.383.4

2911 INFRARED PHOTOCONDUCTIVE DETECTORS USING IMPURITY-ACTIVATED GERMANIUM–SILICON ALLOYS. G.A.Morton, M.L.Schultz and W.E.Harty.
R.C.A. Rev., Vol.20, No.4, 599-634 (Dec., 1959).

A new class of sensitive infrared photoconductors is described wherein the long-wavelength limit can be adjusted to meet the requirements of their application in detectors. This makes it possible to minimize the cooling needed to obtain a given detectivity and to reduce background radiation noise. The general theory of impurity-activated photoconductors and the noise which determines their sensitivity in a detector are discussed. The class of extrinsic photoconductors consisting of Ge–Si alloys is studied. The long-wavelength limit is determined by the activator impurity, the alloy composition, and the activator compensation. The performance of gold- and zinc-activated alloys is described in detail. The peak dectectivity, D_λ^*, of the two materials for a given long-wavelength and temperature is approximately the same, but the shapes of their spectral response curves are very different. A zinc-activated alloy with a 14-m long-wavelength limit will have a detectivity of the order of $D_\lambda^* = 2 \times 10$ cm/W when cooled to temperatures attainable with a liquid oxygen–nitrogen mixture at reduced pressure. Such a photoconductor is well suited for application in the long-wavelength atmospheric window. Optical and electronic problems of adapting these photoconductors to detector cells for this and other applications are considered.

539.2 : 537.312 : 621.383.4

2912 CADMIUM SULFIDE PHOTOCONDUCTIVE SINTERED LAYERS. M.J.B.Thomas and E.J.Zdanuk.
J. Electrochem. Soc., Vol. 106, No. 11, 964-71 (Nov., 1959).

The preparation and performance of sintered photoconductive CdS layers are described. Although the photoconductive characteristics are directly dependent on composition, layer preparative techniques, and geometry of the unit, these parameters may be predicted and controlled to give a resultant reproducible layer of desired electrical and optical characteristics.

539.2 : 537.312 : 621.383.4

2913 SINTERED CADMIUM SULFIDE PHOTOCONDUCTIVE CELLS. C.P.Hadley and E.Fischer.
R.C.A. Rev., Vol.20, No.4, 635-47 (Dec., 1959).

Fabrication techniques are discussed, together with the properties of the host materials, activation impurities, electrodes, and packaging. A theory is presented regarding energy-level structure, sensitivity, time effects, geometry, ohmic contacts, and gamma. The characteristics are discussed with respect to practical applications.

Thermoelectric Properties

539.2 : 537.32

2914 THERMOELECTRIC PROPERTIES OF SOME MIXED OXIDES. H.Lessoff, Y.Kersey and R.A.Horne.
J. chem. Phys., Vol. 31, No. 4, 1141 (Oct., 1959).

The electrical resistivities of various compressed and sintered mixed oxides are measured as functions of temperature and their

Seebeck coefficients (thermoelectric power values) are also measured. The Seebeck coefficients either increase slowly or remain constant with temperature although the resistivity shows normal semiconducting behaviour with temperature. It is concluded that the large resistivity values even at high temperatures preclude the use of these materials for electrical power generation.

C.A.Hogarth

539.2 : 537.32

2915 MATERIALS FOR THERMOELECTRIC REFRIGERATION. F.D.Rosi, B.Abeles and R.V.Jensen.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 191-200 (July, 1959).

The electrical conductivity, thermoelectric power and thermal conductivity were measured on Bi_2Te_3 and the alloy systems $(Bi,Sb)_2Te_3$, $Bi_2(Te,Se)_3$ and $(Bi_2Sb)_4(Te,Se)_3$. Criteria determining the optimum properties of the materials for thermoelectric refrigeration are discussed. Thermocouples made up of the above materials have yielded a maximum cooling corresponding to a temperature difference of 65° C between the hot and cold junctions, with the hot junction at 300° K.

539.2 : 537.32

2916 THERMO-ELECTRICITY AT LOW TEMPERATURES. VII. THERMO-ELECTRICITY OF THE ALKALI METALS BETWEEN 2 AND 20° K.
D.K.C.MacDonald, W.B.Pearson and I.M.Templeton.
Proc. Roy. Soc. A, Vol. 248, 107-18 (Oct. 28, 1958).

In earlier work (see Abstr. 5013-14 of 1958) the absolute thermoelectric force, E, of the alkalis was measured from about 60° K down to about 4° K. The absolute thermoelectric power ($S = dE/dT$) could then be derived with fair accuracy down to perhaps 8° K. The thermoelectric power of all the alkali metals has now been measured directly between 2 and 20° K, and the Thomson heats derived therefrom. The results are compared with the theory both of the "normal" thermoelectric power and the Gurevich or "phonon-drag" effect. It is clear from the work that experiments below 1° K in this field will be of much interest and a programme has been started in this temperature range.

539.2 : 537.32

2917 SOLID SOLUTIONS OF Bi_2Te_3 AND Sb_2Te_3 AS P-TYPE WORKING SUBSTANCES FOR SEMICONDUCTOR THERMO-ELEMENTS. K.Šmirous and L.Štourač.
Z. Naturforsch., Vol. 14a, No. 9, 848-9 (Sept., 1959). In German.

A solution of 25% (atomic) Bi_2Te_3 and 75% Sb_2Te_3 with a Te excess of about 4% gave polycrystalline p-type probes with an efficiency as thermo-elements of over 3.5×10^{-3} deg^{-1}. The thermoelectric power α of the probes was found to vary with the electrical conductivity σ according to

$$\alpha = \text{const} - (k/e) \ln \sigma.$$

L.Pincherle

Dielectric Properties

539.2 : 537.2

2918 TEMPERATURE DEPENDENCE OF THE TEMPERATURE COEFFICIENT OF PERMITTIVITY OF $CaZrO_3$ AT LIQUID-HELIUM TEMPERATURE.
N.P.Bogoroditskii, N.M.Reinov and L.A Aleksandrov.
Fiz. tverdodo Tela, Vol. 1, No. 2, 350-2 (Feb., 1959). In Russian.

A maximum of this coefficient, accompanied by a tan δ maximum, was observed at - 245° C, suggesting a structural transition at that temperature. A.Tybulewicz

539.2 : 537.2 : 532.7 : 621.315.61

γ-IRRADIATED SILICONE DIELECTRICS. See Abstr. 2173

539.2 : 537.2

2919 THIN FERROELECTRIC FILMS OF $Pb(Ti,Zr,Sn)O_3$
M.S.Lur'e.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 1, 73-4 (Sept. 1, 1959). In Russian.

$Pb(Ti,Zr,Sn)O_3$ films of 2μ thickness have a rectangular hysteresis loop. The samples show a considerable non-linearity of permittivity under both d.c. and a.c. voltages. The saturating field is several times greater, and the permittivity at low fields is lower, than in bulk samples. At room temperature the breakdown strength can be as high as 300 kV/cm. Z.Krasucki

539.2 : 537.2

2920 FERROELECTRIC PROPERTIES OF LEAD METATANTALATE. V.A.Isupov.
Fiz. tverdogo Tela, Vol. 1, No. 2, 242-5 (Feb., 1959). In Russian.

$PbTa_2O_6$ was prepared by the usual ceramic method. It had a permittivity peak ($\epsilon = 1070$) and a minimum of the volume coefficient of expansion at 240° C. The latter indicated positive volume electrostriction. Saturation in hysteresis loops was not observed in fields up to 50 kV/cm. The reasons for this are discussed in terms of spontaneous-polarization directions, and it concluded that spontaneous polarization is not less than 4 μC/cm². A.Tybulewicz

539.2 : 537.2

2921 FERROELECTRIC BEHAVIOR OF THIOUREA.
G.J.Goldsmith and J.G.White.
J. chem. Phys., Vol. 31, No. 5, 1175-87 (Nov., 1959).

The dielectric constant, and the ferroelectric, pyroelectric, and piezoelectric properties of thiourea crystals were measured in the temperature range 90° K to 300° K. At least three dielectric anomalies are found at 169° K, 177° K, and 202° K, the lowest of these corresponding to a pronounced discontinuity. The crystals are ferroelectric in two regions, below 169° K and between 176° K and 180° K. Substitution of deuterium for hydrogen causes the anomalies to move upwards in temperature by 16°, 16°, and 11°, respectively. The crystal structure has been determined in detail at 120° K in the lower ferroelectric region. The transition from the antiferroelectric room temperature structure to the ferroelectric state is accomplished by small rotations of the molecules such that two of the molecules in the crystal unit cell have tilts to the ferroelectric b axis appreciably different from the other two, and the resultant of the molecular dipoles along [010] is no longer zero. The ferroelectric reversal is thus easily accomplished by interchanging the tilts of the two pairs of molecules.

539.2 : 537.2 : 535.33

FERROELECTRIC POLARIZATION AND X-RAY SPECTRUM OF $BaO.TiO_2$. See Abstr. 1739

539.2 : 537.2

2922 ON THE PROBLEM OF THE PERMITTIVITY DISPERSION OF BARIUM TITANATE. J.Fousek.
Czech. J. Phys., Vol. 9, No. 2, 172-85 (1959).

The complex permittivity of multidomain single crystals of $BaTiO_3$ was measured in the decimetre and centimetre wave bands and it was proved that in this frequency region there is dispersion of the permittivity. Apparatus for measuring the permittivity of substances with a high ϵ' is described and the influence of the inhomogeneity of the field in the sample on the characteristics of the cavity resonator is calculated. Present theories of the high-frequency properties of $BaTiO_3$ are discussed from the point of view of the experimental results.

539.2 : 537.2

2923 ON THE HIGH-TEMPERATURE COMPATIBILITY OF CESIUM GAS WITH SOME DIELECTRICS.
P.Wagner and S.R.Coriell.
Rev. sci. Instrum., Vol. 30, No. 10, 937-8 (Oct., 1959).

Eight refractory dielectrics were exposed, under controlled conditions, to caesium gas at temperatures as high as 1475° C. The apparatus designed for this work and results of this investigation are discussed.

539.2 : 537.2

2924 THE ROLE OF FIELD IN FORMATION OF HETEROCHARGE OF A PHOTOELECTRET.
B.M.Golobin, N T.Kashukeev and V.M.Fridkin.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 1, 63-6 (Sept. 1, 1959). In Russian.

An expression is derived for the stationary distribution of heterocharge along the length of the crystal in the direction of the applied field. It follows from the equation that the charge on the surface of photoelectret facing the anode is directly proportional to the intensity of the polarizing field, and the charge on the opposite surface is independent of the field intensity. Z.Krasucki

539.2 : 537.2

2925 CERAMIC ELECTRETS.
E.Schleicher.
Exper. Tech. der Phys., Vol. 7, No. 4, 168-81 (1959). In German.

Specimens of barium titanate of various thicknesses were polarized, the charge remaining on the electrodes being measured over

a period of several months. The effect of various electrode materials and of the method of storage (on open or short circuit) were investigated. It was concluded, by testing very thin plates, that a denser fine-grained surface skin is produced during firing of the ceramic. If this is removed by grinding, the electrode metal may diffuse into the body of the sample. K.W.Plessner

539.2 : 537.2

2926 X-RAY INDUCED ELECTRICAL POLARIZATION IN GLASS. T.M.Proctor.

Phys. Rev., Vol. 116, No. 6, 1436-40 (Dec. 15, 1959).

Electrical polarization was induced in a lead silicate glass by the action of X-rays. This phenomenon is surveyed experimentally as a function of total dose (incident and absorbed), dose rate, X-ray tube potential, radiation temperature, and temperature at which the polarization is released and measured. Net surface charges of the order of 10^{-9} Coulomb/cm^2 can be obtained from 3 mm thick samples irradiated at room temperature with 10^5 r of 250 kV X-rays. To the first order the build-up and decay of this condition seems to follow the normal electrical relaxation as can be theoretically predicted from the dielectric and resistivity constants of the material ($\tau = \rho\epsilon$). Measured surface charge is shown to be proportional to absorbed dose for smaller doses; however, for greater doses final equilibrium in the polarization is reached when back electrical conduction becomes as large as the forward X-ray induced displacement current. The dependence of measured surface charge upon the sample thickness was experimentally investigated for one case.

539.2 : 537.2

2927 THE EFFECT OF HIGH PRESSURES ON DIELECTRIC LOSSES OF POLYMERS.

L.A.Igonin, Yu.V.Ovchinnikov and V.A.Kargin.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 1, 127-9 (Sept. 1, 1959). In Russian.

Tan δ of polymers, such as polyvinylchloride, polymethylcrylate, and polymethylmethacrylate, was measured at frequencies of 400, 1000 and 5000 c/s, at pressures of up to 2448 kg/cm^2 and over the temperature range from 20° to 90°C. With increasing pressure the maximum in the tan δ versus temperature plot is shifted to higher temperatures. This indicates that in these polymers the mobility of molecular chains changes under compression. Z.Krasucki

539.2 : 537.2

2928 INVESTIGATION OF THE PIEZOELECTRIC EFFECT IN QUARTZ-CONTAINING ROCKS UNDER FIELD CONDITIONS. M.P.Volarovich, É.I.Parkhomenko and G.A.Sobolev.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 525-8 (Sept. 21, 1959). In Russian.

By measuring the elastic and electric vibrations produced in a rock, when an explosion is made at a short distance it is possible to measure the piezoelectric effect. Values of 0.05 to 0.5% of that for monocrystalline quartz have been found in the gneiss of the Urals and granite-gneiss of Kazakhstan. J.M.Hough

OPTICAL PROPERTIES OF SOLIDS

539.2 : 535 : 621.383.2

2929 SOLID-STATE OPTOELECTRONICS. E.E.Loebner.

R.C.A. Rev., Vol. 20, No. 4, 715-43 (Dec., 1959).

Discusses the uses of photoelectric and luminescent phenomena. A description is given of optico-electronic modulators and amplifiers, i.e. devices which have mixed optical and electrical signal and power access. The technology of assembling image-transmitting, image-storing, and picture-reproducing panels from optico-electronic elements is reviewed. The function of various optico-electronic logic nets and computer components is treated in detail. A synthesis of panel technology and logic circuitry into novel picture-processing panels and computer systems is proposed. The similarity between the organizational structure of such parallel processing systems and that of the neuron network of vertebrate retinas is pointed out.

539.2 : 535

2930 EFFECTS OF ELECTRON CORRELATION ON THE OPTICAL PROPERTIES OF METALS. P.A.Wolff.

Phys. Rev., Vol. 116, No. 3, 544-54 (Nov. 1, 1959).

Many-body perturbation theory is used to determine the effect of electron–electron correlation on the optical properties of metals. The formula for the current induced in such a system by an electromagnetic wave is written in such a form that it may be conveniently evaluated with diagrammatic techniques. Lowest order diagrams give the usual conductivity of a noninteracting electron gas. First order (in the Coulomb field) diagrams are typical of the random phase approximation and do not appreciably influence the conductivity. In second order processes outside the random phase approximation occur, and have an important effect on the optical properties. A formula is derived for the contribution of such diagrams to the conductivity. It gives a vanishing correction for the case of the free electron gas (where current, as well as momentum, is conserved in electron–electron collisions) but a finite value for real metals in which electron current and momentum are not proportional to one another. This formula is used to discuss the optical properties of the double (electron-hole) plasma that occurs in metals with overlapping bands. In this instance correlation causes a shift in the dielectric anomaly (defined as the point at which the real part of the dielectric constant is zero), and produces absorption through processes in which an electron and hole share the energy of an incoming photon.

539.2 : 535

2931 BIREFRINGENCE IN UNIAXIAL SEMICONDUCTING CRYSTALS.

A.V.Sokolov, G.I.Kharus and V.P.Shirokovskii.

Fiz. tverdogo Tela, Vol. 1, No. 2, 354-6 (Feb., 1959). In Russian.

Considering only electron transitions between the valence and conduction bands (neglecting the effects of free carriers, lattice vibrations, lattice defects and impurities) in a hexagonal crystal of D_3 symmetry, the authors show that uniaxial semiconductors should be birefringent. It is also shown that a hexagonal crystal of D_3 symmetry should be transparent to light polarized parallel to the hexagonal axis and perfectly reflecting for light polarized at right angles to that axis. A.Tybulewicz

539.2 : 535

2932 POLARIZED LIGHT TRANSMISSION OF $BaTiO_3$ SINGLE CRYSTALS. R.C.Casella and S.P.Keller.

Phys. Rev., Vol. 116, No. 6, 1469-73 (Dec. 15, 1959).

Optical transmission and reflection measurements were made on poled $BaTiO_3$ single crystals in the tetragonal phase (crystal class C_{4v}) with light polarized parallel and perpendicular to the c axis. The absorption coefficients, $\mu_\parallel$ and $\mu_\perp$ are presented as functions of the incident photon energy at room temperature. At the absorption edge, $\mu_\perp > \mu_\parallel$. A theoretical basis for this selection rule, which was derived from first principles, is presented. The theory represents a generalization of earlier work on wurtzite crystals and extends the applicability of the wurtzite selection rule to all solids in the crystal classes, C_{nv} and C_n, where n = 3, 4, or 6. Limitations of the theory are discussed. The dichroic effect in $BaTiO_3$ was also studied experimentally at elevated temperatures, in the vicinity of the Curie point. It is concluded that the extrema of the valence and conduction bands of $BaTiO_3$ probably lie at (or very close to) the origin of the Brillouin zone.

539.2 : 535

2933 FARADAY EFFECT IN CERIUM PHOSPHATE GLASSES AT LOW TEMPERATURES. P.B.Alers.

Phys. Rev., Vol. 116, No. 6, 1483 (Dec. 15, 1959).

The Faraday effect in glass specimens containing cerium metaphosphate in various concentrations was measured at 4.2° and 1.8°K, using 5461 A light, in magnetic fields ranging to 70 kilogauss. The curves of rotation versus H/T were fitted to the Brillouin function for $J = \frac{1}{2}$, yielding values of $g = 1.75$ and $\beta = 0.874$ Bohr magneton. The observed rotations were quite large; for the glass containing the highest concentration of cerium, the rotation approached a saturation value of 4.76π radians/mm.

539.2 : 535

2934 MAGNETO-OPTIC STUDIES IN THE NITRATES OF LEAD, BARIUM AND STRONTIUM. V.Sivaramakrishnan.

Proc. Indian Acad. Sci. A, Vol. 44, No. 4, 216-22 (May, 1957).

The Verdet constant has been determined for the nitrates of lead, barium and strontium from 5780 to 3650 A. Dispersion formulae have been constructed for both optical refraction and magneto-optic rotation using the same absorption frequencies in both. In these nitrates it is found that the value of magneto-optic anomaly

factor is different for the different absorption wavelengths of the substance and the value of γ for the frequency corresponding to the nitrate ion is extremely low, and is equal to 0.06. The results indicate that the binding in barium and strontium nitrates may be more covalent than that in lead nitrate.

539.2 : 535.3

2935 APPLICATION OF THE METHOD OF MODULATED INCIDENT FLUX TO THE STUDY OF THE REFLECTION OF REFRACTORIES AND OF THE ABSORPTION OF FLAMES IN THE INFRARED. R.Alègre.
Ann. Phys. (Paris), Ser. 13, Vol. 4, No. 3-4, 287-332 (March-April, 1959). In French.

Methods of measuring diffuse reflection (ρ) in the infrared up to 12 μ are reviewed and a method using a chopped beam described. ρ,λ curves for seven refractories of varying composition are given, for temperatures up to about 1000°C. From the emissivities of flames deduced from measurements of their transmission, the best type of refractory for efficient heat transfer is discussed.

G.F.Lothian

539.2 : 535.3

2936 OPTICS OF ABSORBING CRYSTALS. IV. CLASSIFICATION. F.I.Fedorov.
Optika i Spektrosk., Vol. 5, No. 4, 450-61 (1958). In Russian.

For Pt III see Abstr.179 (1960). Discusses all possible types of absorbing crystals of lower syngonies from the point of view of the number and nature of the optical axes. It is shown that isotropic optical axes may be present in such crystals. In contrast to transparent crystals the optical properties of absorbing crystals of rhombic, monoclinic and triclinic syngonies differ essentially between each syngony. The total number of various types of absorbing crystals reaches 16, instead of 3 in Voigt–Drude's theory. A complete classification of absorbing non-active non-magnetic crystals according to their optical properties is given.

A.Tybulewicz

539.2 : 535.33

2937 ULTRAVIOLET ABSORPTION OF ALKALI HALIDES. J.E.Eby, K.J.Teegarden and D.B.Dutton.
Phys. Rev., Vol. 116, No. 5, 1099-105 (Dec. 1, 1959).

The absorption spectra of evaporated films of the alkali halides, with the exception of LiF, were measured at room temperature and 80°K in the region from 1100 to 2500 A. The spectra are rather complex at low temperature, but agree fairly well with current theory concerning the multiplicity and grouping of the exciton peaks (see Abstr. 2810 of 1960). In addition, a shoulder was found in many of the spectra, similar to the ones previously seen and associated with the band-to-band transition in the alkali iodides.

539.2 : 535.33

2938 THE ABSORPTION SPECTRUM OF KCl:Ca COLOURED BY X- AND γ-RADIATION. P.Coufová.
Czech. J. Phys., Vol. 9, No. 2, 168-71 (1959). In Russian.

A description is given of the splitting up of the F-band (maximum around 0.55 μ) into bands with maxima at 0.54 and 0.56 μ, which are observed on colouring by γ-radiation, by X-rays, or after decolouring the sample by light at 0.54 μ. With repeated colouring and annealing there occurs an irreversible transition $F \rightarrow Z_2$ up to a certain value k_m of the F-band. The magnitude of this coefficient depends on the colouring radiation and the total dose absorbed, and not on the dose intensity.

539.2 : 535.33

2939 INFRARED STUDIES OF CRYSTAL BENZENE. I. THE RESOLUTION AND ASSIGNMENT OF ν_{20}, AND THE RELATIVE MAGNITUDES OF CRYSTAL FIELDS IN BENZENE. C.A.Swenson, W.B.Person, D.A.Dows and R.M.Hexter.
J. chem. Phys., Vol. 31, No. 5, 1324-8 (Nov., 1959).

Under the higher resolution available with double pass prism and small grating infrared spectrometers, it has finally been possible to observe splitting of the degenerate fundamentals of benzene in the solid phase. Three components were found for ν_{20} at 1032.6, 1034.7, and 1039.4 cm^{-1}, as predicted by Zwerdling and Halford. These are assigned to the absorptions along the b, c, and a axes, respectively, by a mixed crystal study of benzene-d_6 in benzene combined with the polarized work of Zwerdling and Halford. The crystal splitting of ν_{20} was also observed in the benzene-d_6 crystal, showing components at 806.5, 808.5 and 812.2 cm^{-1} assigned to absorptions along the b, c, and a axes, respectively. The magnitudes of the static and correlation fields are thus found to be similar, contrary to the ideas advanced by Zwerdling and Halford, and long accepted intuitively. The effect of temperature on the appearance of the spectrum was studied. An explanation for the changes observed is advanced on the basis of the assignment which is consistent with it, and supports it.

539.2 : 535.33

2940 INFRARED SPECTRUM OF CRYSTALLINE BORON TRIFLUORIDE. D.A.Dows.
J. chem. Phys., Vol. 31, No. 6, 1637-9 (Dec., 1959).

Infrared spectra of various mixtures of isotopically substituted boron trifluorides are presented. The samples were studied in the solid state at 83°K, and in the spectral range covering all fundamental vibrations. Multiplet structures and shapes of the absorption bands show that the crystal structure is not isomorphous with that of boron trichloride and tribromide, and that rather strong intermolecular coupling of vibrations prevails.

539.2 : 535.33

2941 INFRARED ABSORPTION SPECTRUM OF THE SILICATE ION IN THE GARNET STRUCTURE. K.A.Wickersheim, R.A.Lefever and B.M.Hanking.
J. chem. Phys., Vol. 32, No. 1, 271-6 (Jan., 1960).

Infrared absorption bands at 912 and 861 cm^{-1} exhibited by some crystals of yttrium iron garnet and similar bands exhibited by some rare earth iron garnet crystals have been identified as vibrational fundamentals of a silicate ion impurity. The bands are assigned to split components of a triply degenerate vibration (ν_3) of the tetrahedral SiO_4 ion. The splitting of this vibration into a nondegenerate and a doubly degenerate vibration is attributed to distortion of the silicate ion along an S_4 axis by the garnet structure. Integrated absorption measurements identify the 912 cm^{-1} as the nondegenerate component. Information obtained from the isolated silicate ion in yttrium iron garnet is used to interpret the spectra of the silicate garnets. Complete removal of the degeneracy of vibrations arising from ν_3 is observed in the silicate garnets, suggesting that the majority of the silicate ions possess a local symmetry lower than that predicted by the assigned space group $Ia3d$–Oh^{10}.

539.2 : 535.33

2942 SHIFT OF ABSORPTION LINES OF SINGLE CRYSTALS ON TRANSITION TO SMALL FILM THICKNESSES. H.Lämmermann.
Naturwissenschaften, Vol. 46, No. 17, 511 (1959). In German.

Measurements on single crystals of $Pr(NO_3)_3.6H_2O$ at liquid helium temperature show shifts of absorption bands of a few cm^{-1} towards lower energy when the film thickness is reduced to 10μ. The exact shift varies with the absorption line and the crystal direction.

G.F.Lothian

539.2 : 535.33

2943 EXCITON SPECTRUM OF CADMIUM SULFIDE. D.G.Thomas and J.J.Hopfield.
Phys. Rev., Vol. 116, No. 3, 573-82 (Nov. 1, 1959).

The reflectance and fluorescent spectra of hexagonal CdS crystals were measured at 77° and 4.2° K using polarized light in the region of 5000 A. Structure not previously reported was found in the reflectivity curves which leads to the identification of three exciton series. These can be understood in terms of the splitting of the valence band into three levels at k = 0. The observation of excited exciton states and the polarization properties of the excitons make possible: (1) The determination of two of the three exciton binding energies; (2) the determination of the energy splittings of the three valence bands; (3) the verification of the symmetry assignments of the valence and conduction bands; and (4) correlation of the work of others with the present work, showing that the definite intrinsic effects are consistent both with these observations and interpretations. The fluorescent experiments strongly suggest that the radiative decay of excitons occurs not directly, but from localized impurity exciton states in agreement with theory.

539.2 : 535.33 : 534.8

2944 INFLUENCE OF ACOUSTIC VIBRATIONS ON THE PARAMETERS OF THE IMPURITY-ABSORPTION BANDS IN CRYSTALS. V.L.Vinetskii and M.F.Deigen.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 287-9 (July, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No.1, 198-9 (Jan., 1959).

The parameters depend on the sums $q_1 = \Sigma \cos^2\theta_\alpha/l_\alpha^2$ and $q_0 = \Sigma \cos^2\theta_\alpha/l_\alpha$, where θ is the angle between the displacement vector and the wave vector for the αth branch of elastic vibrations ($\alpha = 1,2,3$) and l_α determines the angular dependence of the frequen-

cies of elastic vibration. Expressions are derived for q_1 and q_2 in terms of the "anisotropy parameter" and the elastic moduli.

B.T.M.Willis

539.2 : 535.33

2945 THE ABSORPTION OF ZnO CRYSTALS IN THE INFRARED. R.Arneth.

Z. Phys., Vol. 155, No. 5, 595-608 (1959). In German.

The infrared absorption of synthetic ZnO single crystals doped and undoped, was measured between 1 and 13 μ. The absorption generally increases with increasing wavelength. Only crystals which were highly Cu doped, or heated in O_2 without further doping, were completely transparent to about 8μ. Absorption maxima occur at 10.1μ and 11.5μ. At a given wavelength the absorption generally increases with conductivity, but for equal conductivity the absorption for crystals heated in H_2 was much smaller than for undoped crystals or crystals heated in Zn vapour. On cooling to 90°K, the absorption increases or decreases depending on the treatment of the crystals. The effects are due to a combination of defect centre absorption and free charge carrier absorption. J.Franks

539.2 : 535.33

2946 RAMAN SPECTRUM OF STRONTIANITE ($SrCO_3$). T.S.Krishnan.

Proc. Indian Acad. Sci. A, Vol. 44, No. 2, 96-8 (Aug., 1956).

The Raman spectrum of strontianite ($SrCO_3$) has been studied for the first time using the 2537 resonance radiation of mercury as the exciter. The observed spectrum has been compared with that of aragonite which is isomorphous with strontianite. Out of the 13 frequency shifts recorded, 5 have been attributed to the internal oscillations of the CO_3 ion and the remaining 8 to the lattice oscillations. The splitting of the degenerate ν_4 vibration of the free CO_3 ion in the crystal into 3 frequencies and also the observed relative intensity of the lines 150 cm^{-1} and 184 cm^{-1} arising from the angular oscillations of the CO_3 ions about their principal axes of inertia, indicate a considerable distortion in the symmetry of the CO_3 ion in strontianite as in the case of aragonite.

539.2 : 535.34

2947 THE RAMAN SPECTRA OF CRYSTALLINE SULPHATES OF Ni AND Mn. D.Krishnamurti.

Proc. Indian Acad. Sci. A, Vol. 48, No. 6, 355-63 (Dec., 1958).

The paper reports the results of investigations on the Raman spectra of $NiSO_4.6H_2O$ (tetragonal and monoclinic forms), $NiSO_4.7H_2O$ (orthorhombic) and $MnSO_4.4H_2O$ (monoclinic). Using 2536.5 resonance radiation of mercury for excitation of the Raman effect, it has been possible to observe a large number of frequency shifts. The spectra exhibit striking differences between themselves and also a few characters of general similarity. These are largely explicable in terms of the crystal symmetry and structure of these substances. In all the cases studied, the internal frequencies of the sulphate ion exhibit multiplicities owing to the lowering of the symmetry of the SO_4 ion in the crystalline state and due to the number of ions present in the unit cell.

539.2 : 535.37

2948 FURTHER INVESTIGATIONS INTO THE EMISSION ANISOTROPY OF PHOTOLUMINESCENCE OF PLEXIGLASS LUMINOPHORS. J.Glowacki, A.Kawski and B.Polacka.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 7, No. 6, 353-5 (1959).

According to theory proposed by Czajkowski and Grzywacz (Abstr. 3889 of 1958) the polarization of luminescence emission should rise with concentration of fluorescent molecules. Results are presented contrary to this theory and it appears that luminescent molecules are excited directly and not via the matrix material. Energy transfer can only take place at high solute concentrations and between solute molecules causing depolarization of emission.

G.F.J.Garlick

539.2 : 535.37

2949 THE DIFFUSION AND NON-RADIATIVE TRANSFER OF EXCITATION ENERGY IN MOLECULAR CRYSTALS CONTAINING FOREIGN MOLECULES. M.Trlifaj.

Czech. J. Phys., Vol. 9, No. 1, 4-15 (1959).

Includes a discussion of the luminescent properties of these crystals.

539.2 : 535.37

2950 OPTICAL SPECTRA OF RARE EARTH ACTIVATED $BaTiO_3$. S.P.Keller and G.D.Pettit.

J. chem. Phys., Vol. 31, No. 5, 1272-7 (Nov., 1959).

$BaTiO_3$ was activated with Pr, Sm, Eu, Dy, or Er ions. The fluorescence spectra were determined at −196°C, −28°C, room temperature, and at 130°C. Crystalline field effects on the energy levels of the rare earths and changes in these effects as the crystallographic phase of $BaTiO_3$ is changed were looked for, in particular, changes at the Curie point in going from the ferroelectric tetragonal phase to the cubic phase. The high temperature data were largely unresolvable and no changes were observed at the low-temperature transitions in going from the tetragonal to the orthorhombic phase in the range of 5 to 13°C and from orthorhombic to the rhombohedral phase in the range of −70 to −80°C. No crystal field splittings were observed at any temperature, leading to the possible conclusion that the rare earth centres are in positions of either high symmetry or low field strength. The fluorescence data support the hypothesis that the rare earths are present as the trivalent ions and that they can be assigned energy levels and term signatures resulting from the $4f^n$ configuration.

539.2 : 535.37

2951 THE LUMINESCENT CENTER IN SELF-ACTIVATED ZnS PHOSPHORS. J.S.Prener and D.J.Weil.

J. Electrochem. Soc., Vol. 106, No. 5, 409-14 (May, 1959).

A model for the ground state of the self-activated luminescent centre proposed by Prener and Williams (1956) has been confirmed experimentally. It is shown that a Zn vacancy is involved in the blue luminescence and that the spectrum depends on whether the required coactivator can occupy a Zn or S site near the vacancy. The calculated energy levels of the centre using a simple model are in qualitative agreement with the observed spectra.

539.2 : 535.37

2952 OPTICAL PROPERTIES OF TIN- AND LEAD-ACTIVATED CALCIUM METASILICATE PHOSPHORS. R.W.Mooney.

J. Electrochem. Soc., Vol. 106, No. 11, 955-9 (Nov., 1959).

The preparation and optical properties of two metasilicate phosphors are described. The more efficient of these is a β-$CaSiO_3$:Sn phosphor emitting in the visible at about 520 mμ. The optical properties of the tin-activated species are compared to their lead-activated analogues; and from considerations of crystal structure as affected by firing temperature and activator concentration, it is concluded that changes in spectra result from changes in crystal structure and not from the degree of aggregation of the activator ions. It is suggested that the emission spectra correspond to the $^3P_1^0 \rightarrow {}^1S_0$ and the $^1P_1^0 \rightarrow {}^1S_0$ transitions of the lead- and tin-activator centres.

539.2 : 535.37

2953 PHASE EQUILIBRIA AND MANGANESE-ACTIVATED FLUORESCENCE IN THE SYSTEM $Zn_3(PO_4)_2$–$Mg_3(PO_4)_2$. J.F.Sarver, F.L.Katnack and F.A.Hummel.

J. Electrochem. Soc., Vol. 106, No. 11, 960-3 (Nov., 1959).

Determination of the phase relationships on the $Zn_3(PO_4)_2$–$Mg_3(PO_4)_2$ join by the quench method has enabled the previously designated "gamma zinc phosphate" to be identified as a solid solution of zinc orthophosphate in magnesium orthophosphate. $Mg_3(PO_4)_2$ takes 95 mole % $Zn_3(PO_4)_2$ into solid solution at 1000° C. β-$Zn_3(PO_4)_2$ takes a small amount of $Mg_3(PO_4)_2$ into solid solution (about 3 mole % at 1000°) and, in order to satisfy the requirements of the Phase Rule, α-$Zn_3(PO_4)_2$ must take a small amount of $Mg_3(PO_4)_2$ into solution. The previously determined $Zn_3(PO_4)_2$–$Mg_3(PO_4)_2$ relationships are discussed in terms of the new data for the zinc-magnesium orthophosphate system. Solid solution relationships in the system MgO–ZnO–P_2O_5 are diagrammed and discussed. Data on peak emission and brightness of the β-$Zn_3(PO_4)_2$ solid solution and the $Mg_3(PO_4)_2$ solid solution were obtained using molar substitutions of manganese as an activator. The brightness of the β-$(Zn,Mg)_3(PO_4)_2$: Mn solid solutions compares favourably with commercial β-$Zn_3(PO_4)_2$: Mn phosphors and the N.B.S. standard. The manganese-activated phosphors near the high zinc end of the $Mg_3(PO_4)_2$ solid solution series are very bright relative to the β-$Zn_3(PO_4)_2$: Mn standard, but they peak near 6280 A, which may in part account for the higher brightness.

539.2 : 535.37

2954 WAVE-LENGTH DEPENDENCE OF THE QUANTUM EFFICIENCY AND ABSORPTION OF POWDER PHOSPHORS. Y.Uehara, I.Masuda and Y.Kobuke.

J. Electrochem. Soc., Vol. 107, No. 1, 1-8 (Jan., 1960).

A number of powder phosphors have been measured by a direct

optical method. Results are compared with other published values. Although slight discrepancies are found for magnesium and calcium tungstate at the 2537 A position, the maximum quantum efficiency for magnesium tungstate is in good agreement with the published values. Good agreement is also found for impurity-activated phosphors. New data are presented for a number of ortho-phosphates. The quantum efficiency curves decrease more rapidly than the absorption curves toward both longer and shorter wavelengths from the peak position. The peaks of the quantum efficiency curves lie at longer wavelengths than those of the absorption curves. Reasons for these differences are discussed.

539.2 : 535.37

2955 TIN-ACTIVATED ALKALINE-EARTH PYROPHOSPHATE PHOSPHORS. R.C.Ropp and R.W.Mooney.
J. Electrochem. Soc., Vol. 107, No. 1, 15-20 (Jan., 1960).

The preparation and properties of the Group II metal pyrophosphates activated by tin are described. It is shown that the fluorescent emission is strongly dependent on the matrix shifting toward higher wave lengths with increasing size of the cation of the pyrophosphate. Excitation and emission spectra of many of the phosphors are given. The most useful of these phosphors is $Sr_2P_2O_7$:Sn, a very efficient blue phosphor emitting at 452 mμ.

539.2 : 535.37

2956 A THEORY OF EDGE-EMISSION PHENOMENA IN CdS, ZnS AND ZnO. J.J.Hopfield.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 110-19 (July, 1959).

Tentative symmetry assignments of p valence bands and s conduction bands can be made for ZnO and CdS on the basis of a tight-binding model. The six-fold degenerate p-bands are split in hexagonal crystals into a four-fold degenerate and a two-fold degenerate band. The four-fold degeneracy is split by spin-orbit coupling. The polarization of recombination radiation depends upon which band the hole belongs to, and is almost independent of the recombination mechanism. The polarization of the edge emission (the series of equally spaced emission lines) should be strongly temperature-dependent. Quantitative agreement is obtained between the predictions of this band model for CdS and the edge-emission polarization experiments of Dutton (Abstr. 10806 of 1959). It is shown that the spectra of edge-emission cannot be reasonably explained without the introduction of impurities or surfaces to absorb crystal momentum. In CdS, recombination from a shallow trap seems necessary to explain the large coupling to the lattice apparent in the observed emission spectrum. The edge-emission spectrum should approximate a Poisson distribution for recombination from a trap. The mean number of emitted phonons is a measure of the radius of the trapped carrier-wave function.

539.2 : 535.37

2957 TRAPPED CHARGE AND THE LOW-TEMPERATURE LUMINESCENCE OF UNDOPED KI.
K.Teegarden and R.Weeks.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 211-16 (July, 1959).

New data are presented on the previously reported low-temperature blue luminescence of undoped KI. It is shown that the emission previously observed during irradiation in the fundamental bands can also be stimulated by irradiation in the F- and F'-bands formed by exposure to ultraviolet light at 93°K. The crystals display a burst of red luminescence when warmed after irradiation with light absorbed in the fundamental bands at 93°K. No emission upon irradiation in the F-band at 93°K occurs if the F-centres have been formed at room temperature. It is suggested that the red luminescence occurs when holes are released from traps during warming and that the blue luminescence is due to the recombination of electrons with trapped holes at 93°K.

539.2 : 535.37

2958 DEPENDENCE OF THE LIGHT-SUM STORED AT LEVELS OF VARIOUS DEPTH ON THE EXCITATION INTENSITY. Yu.M.Popov.
Optika i Spektrosk., Vol. 6, No. 6, 764-8 (June, 1959). In Russian.

A theoretical explanation is given of the experimental observation that, under steady-state conditions in luminescence, the ratio of the light-sums stored in deep and in shallow levels decreases with increase of the excitation intensity. It is shown that under steady-state conditions the ratio of the number of electrons stored at deep levels to the number stored at shallow levels is proportional to the product of two quantities: one of which is the ratio of the total numbers of deep and shallow levels; the other, a quantity which decreases with increase of the excitation intensity. The explanation given does not involve an assumption of de-exciting action of the excitation flux. A.Tybulewicz

539.2 : 535.37

2959 DEPENDENCE OF THE FORBIDDEN GAP AND LUMINESCENCE GROUND-STATE ENERGIES OF (ZnCd)S:Ag ON THE CONCENTRATION OF CdS. G.E.Cross.
Phys. Rev., Vol. 116, No. 6, 1478-80 (Dec. 15, 1959).

A series of (ZnCd)S:Ag:Cl phosphors were studied to determine the effect of increased CdS content on the forbidden gap and on the energy of the ground states associated with luminescence. This work is correlated with that of other workers to confirm the presence of two separate ground states and to show that the luminescence of of this material may be adequately explained by the Klasens model. Also the uniform translation of the spectral peaks (while retaining their shape) emphasizes the long-range order aspects of these phosphors.

539.2 : 535.37

2960 SELF-ABSORPTION AND TRAPPING OF SHARP-LINE RESONANCE RADIATION IN RUBY.
F.Varsanyi, D.L.Wood and A.L.Schawlow.
Phys. Rev. Letters, Vol.3, No.12, 544-5 (Dec. 15, 1959).

The details of the sharp-line fluorescence were examined by high-resolution optical spectroscopy. The only transition at 4°K was from ^2E to $^4A_2$. At 77°K the radiative life-time varied from 4.3 ms for a finely dispersed powder to 15 ms for a boule. This observation confirms the predominantly radiative character of the decay of the excited state and the strong self-absorption of the resonance radiation. B.T.M.Willis

539.2 : 535.37

2961 THE TEMPERATURE DEPENDENCE OF THE INTENSITY OF INORGANIC CRYSTALLINE LUMINOPHORS. H.Witzmann and J.Buhrow.
Z. phys. Chem. (Leipzig), Vol. 210, No. 1-2, 97-101 (Jan., 1959). In German.

The luminescence-temperature relation obtained from the energy-configurational coordinate model of emission centres is examined. Modifications are made for the presence of metastable states and theoretical values of maximum emission efficiency temperatures estimated for some phosphate phosphors showing good agreement with experimental results. G.F.J.Garlick

539.2 : 535.37

2962 RADIOLUMINESCENCE FROM β RADIATION. G.Parolini.
Energia nucleare, Vol. 6, No. 9, 571-87 (Sept., 1959).

Concerns the emission of light by a fluorescent salt excited by β radiation. The first part outlines the theoretical relations and describes the experimental equipment, the preparation process of samples and methods used for the measurement and the evaluation of results. The second part concerns the results of a comprehensive series of measurements which were carried out in order to determine the luminance of the samples under the action of β radiation as well as the efficiency of the process. Such measurements show the influence of the amount of fluorescent salt per unit area of the sample and the influence of diameter of the granules. The results obtained show satisfactory agreement with the theory. As a conclusion, suggestions are given for further research in order to obtain higher values, both of luminance and efficiency.

539.2 : 535.37

2963 THE CATHODOLUMINESCENCE EFFICIENCY OF THIN MICROCRYSTALLINE LAYERS.
G.Gergely, I.Hangos, K.Tóth, J.Ádám and G.Pozsgay.
Z. phys. Chem. (Leipzig), Vol. 210, No. 1-2, 11-22 (Jan., 1959).

Screens were excited by a raster at 10-15 kV in a demountable tube. The light emission was measured on both sides, on the bombarded side by a spectroradiometer. The optical characteristics of screens are discussed in relation to their effects on light output. For silicates energy conversion efficiencies of 6-8% are recorded, for sulphides 6-20%; some observations were made on the effect of increased voltage. ZnS with 16 different additions at 10^{-4} concentrations gave efficiencies between 8 and 15%. S.T.Henderson

539.2 : 535.37

2964 ON THE PHOTO-ELECTROLUMINESCENCE OF ZnS—Cu. K.Pátek.
Czech. J. Phys., Vol. 9, No. 2, 161-7 (1959).

The influence of weak u.v. irradiation on the brightness waves of electroluminescence is investigated for two types of ZnS:Cu phosphor. The observed effects (increase in brightness in the primary peak and its phase shift, are the disappearance of the secondary peak) are explained on the basis of current accepted electroluminescence models.

539.2 : 535.37

2965 THE ACTION OF NICKEL AND COBALT IN ELECTROLUMINESCENT ZINC SULFIDE PHOSPHORS.

P.Goldberg.

J. Electrochem. Soc., Vol. 106, No. 11, 948-54 (Nov., 1959).

Nickel and cobalt produce many of the effects in electroluminescent phosphors that are known for photo- and cathodoluminescent ZnS. In addition, these elements bring to electroluminescent phosphors other changes in properties which are of practical and theoretical interest. Among these are (a) enhancement of emittance in blue-emitting phosphors, (b) marked changes in emittance-voltage and emittance-frequency characteristics, and (c) simplification of the brightness waveforms. The frequency and brightness wave effects can be understood in terms of "fast" and "slow" recombination processes which are influenced differently by the iron-group elements The enhancement of electroluminescence is of uncertain origin but may arise from changes in the photocapacitive properties of the powder crystals due to the iron-group elements. The similarities and differences of nickel and cobalt in both blue and green-emitting phosphors are discussed.

539.2 : 535.37 : 621.383.2.032.35

2966 MICROSCOPIC OBSERVATIONS OF ELECTROLUMINESCENT PHOSPHORS. A.Kremheller.

J. Electrochem. Soc., Vol. 107, No. 1, 8-12 (Jan., 1960).

The electroluminescent brightness of single phosphor particles is studied microscopically in liquid dielectric cells. A simple visual technique in conjunction with a microscope permits one to analyse the brightness distribution within and among electroluminescent particles. Some experimental results are presented on the nonuniformity of the emission, the influence of ball milling and acid etching on the brightness, the improvement of brightness by particle separation, the analysis of the integrated light output as a function of the processing temperature, and the brightness changes due to particle orientation, contact, and irradiation.

539.2 : 535.37 : 621.383.2.032.35

2967 VOLTAGE DEPENDENCE AND PARTICLE SIZE DISTRIBUTION OF ELECTROLUMINESCENT PHOSPHORS. W.Lehmann.

J. Electrochem. Soc., Vol. 107, No. 1, 20-6 (Jan., 1960).

The particle sizes of electroluminescent ZnS phosphors prepared by common firing techniques usually range over broad distributions which always have the same shape. Every phosphor of this "normal" particle size distribution shows a voltage (V) dependence of electroluminescent brightness (L) which, over many decades of L, can closely be described by

$$L = L_0 \exp [-(V_0/V)^{0.5}].$$

Every deviation of the particle size distribution from the "normal" form also causes a deviation of the measurable L(V) dependence from this expression. Measurement on phosphor particles and on uniform phosphor films indicate that the basic excitation mechanism of electroluminescence follows the voltage dependence

$$L = L_0 \exp [-(V_0/V)]$$

and that the square root in the exponent of the usual equation is due mainly to the broad particle size distribution of regular phosphors. This view is supported also by a mathematical analysis.

539.2 : 535.37

2968 EFFICIENCY OF ELECTROLUMINESCENCE IN ZnS. G.Neumark.

Phys. Rev., Vol. 116, No. 6, 1425-32 (Dec. 15, 1959).

The efficiency is examined on the basis of a model of impact ionization in a barrier. On the basis of such a model, the efficiency depends on the ionization rate, and this rate is calculated by applying to ZnS a theory developed for Ge and Si. By considering the voltage dependence of the efficiency one can then get an estimate of a maximum obtainable efficiency in terms of the ratio of the barrier voltage to the total voltage. Both on the basis of this maximum efficiency and from other considerations it appears that the present theory can account for the magnitude of efficiencies reported to date.

539.2 : 535.37 : 621.383.2.032.35

2969 ELECTROLUMINESCENCE OF POLYCRYSTALLITES. S.Larach and R.E.Shrader.

R.C.A. Rev., Vol.20, No.4, 532-63 (Dec., 1959).

The important aspects of luminescence and of electroluminescence are discussed, including incandescence, differences between electroluminescence and other types of luminescence, designing electroluminescent materials to emit in any desired (visible) spectral range, nature of the energy-absorbing layer, and various electrical and optical aspects of the electroluminescence from polycrystallites.

539.2 : 535.37

2970 ON THE ENHANCEMENT AND QUENCHING OF THE LUMINESCENCE OF MANGANESE-ACTIVATED ZINC SULPHIDES BY ELECTRIC FIELDS. H.Gobrecht and H.E.Gumlich.

Z. Phys., Vol.156, No.3, 436-55 (1959). In German.

Previous work is surveyed. Results are reported for ZnS with a range of Mn activator concentrations, tested in the usual electroluminescent cell. In general, the short wavelength end of the emission to X-rays or ultraviolet is diminished by an applied a.c. field, whereas the yellow emission is increased for preparations with certain Mn concentrations. Details are given of the effects of different field frequencies and different excitation intensities. The enhancement or quenching increase with field increase, but at less than a linear rate; presumably part of the energy lost from the "blue" centres is transferred to the "yellow" ones.

S.T.Henderson

539.2 : 535.37

2971 THERMOLUMINESCENCE OF X-RAY COLORED NaCl CRYSTALS.

A.Halperin, N.Kristianpoller, and A.Ben-Zvi.

Phys. Rev., Vol. 116, No. 5, 1081-9 (Dec. 1, 1959).

Glow curves and thermoluminescence spectra taken at various temperatures during the glow were recorded simultaneously. Spectra were obtained with a rapid-scanning spectrophotometer using a liquid-air cooled photomultiplier in conjunction with a cathode-ray oscilloscope. Peaks of the same wavelength were found to be repeated several times in the temperature range of 80-600° K. Thermal pretreatment was found to enhance the various glow peaks by factors of a few thousands. On prolonged heat treatment the peaks above room temperature were found to decrease in intensity, while those at lower temperatures continue to grow even after 80 hr of heat treatment at 550° C. Essentially the same results were obtained for both natural (Dead Sea) crystals and artificial ones.

539.2 : 535.37 : 621.327.534.25

2972 TRANSLUCENT PHOSPHOR COATINGS IN HIGH-PRESSURE MERCURY-VAPOR LAMPS. C.H.Haake.

J. Electrochem. Soc., Vol. 106, No. 10, 866-70 (Oct., 1959).

The optical conditions in quasi-infinitely thick phosphor plaques and in translucent phosphor coatings of closed lamps are studied. Theory shows, and experiments carried out on magnesium fluorogermanate phosphors activated with Mn confirm, that the correlation between the brightness of plaques and of translucent coatings in closed lamps is rather involved. Although prolonged phosphor firing time monotonically increases the former, the latter reaches a maximum and then decreases. This and other unpredictable results render dubious the value of crude plaque brightness tests of phosphors meant for translucent coatings in lamps. Reliable measurements of phosphors for such coatings must include for the main wavelengths of excitation relative quantum efficiencies, reflectances of quasi-infinitely thick phosphor layers, and also differential reflectivities or absorptivities in a thin phosphor layer of a known density.

539.2 : 535.37 : 621.383.2.032.35

2973 PROPERTIES OF A SINGLE-ELEMENT LIGHT AMPLIFIER USING SINTERED CADMIUM SELENIDE PHOTOCONDUCTIVE MATERIAL. F.H.Nicoll.

R.C.A. Rev., Vol.20, No.4, 658-69 (Dec., 1959).

The use of photoconductive sintered cadmium selenide as the control element in a light amplifier offers the possibility of improved gain and speed of response. Such a single-element light amplifier has been made and tested. The results show that moderate gains with high output luminance are possible with speeds in a range

suitable for moving pictures. Very high gains are possible if slow response can be tolerated. Measurements were made over a range of operating frequencies and for various input levels. Data on rise time, decay time and gain for tungsten-light input are given in curve form. From these curves the operating range and input–output light levels for useful picture reproduction can be determined.

539.2 : 535.37 : 621.383.2.032.35

2974 OPTICAL FEEDBACK TYPE STORAGE LIGHT INTENSIFIERS. H.O.Hook.

R.C.A. Rev., Vol. 20, No. 4, 744-52 (Dec., 1959).

Three designs of storage light intensifiers were evaluated by building samples. One design uses a Fotoform glass structure to support the photoconductor and electroluminor and to provide optical isolation of cells. Another uses a transparent (glass or plastic) multiple pedestal structure to provide light paths through the photoconductor and support the active materials. The photoconductor itself provides the optical isolation. The third design uses a flat glass plate as a support, the active materials and optical isolation being built up in layer fashion. Devices of the last type worked best. Typical operation provided optical trigger of 0.1 lm/ft^2 sec, half-hour storage and 0.1 sec erasure in a 12 in.^{2} panel with 250 000 storage cells. With suitable operating conditions, half-tone pictures could be displayed for 1 min. or longer.

539.2 : 535.37

2975 SOLID-STATE, HIGH-INTENSITY MONOCHROMATIC LIGHT SOURCES. I.Wieder.

Rev. sci. Instrum., Vol. 30, No. 11, 995-6 (Nov., 1959).

The extension of optical pumping techniques to solids has been hampered by the lack of suitable light sources. The utilization of photoluminescent effects is proposed as a method for obtaining light sources applicable to optical pumping experiments in some solids, and a ruby source which emits 0.1 W of light at 6934 A and 6920 A is described.

MAGNETIC PROPERTIES OF SOLIDS

539.2 : 538.1

2976 EQUATIONS OF MOTION FOR A SYSTEM CONSISTING OF TWO TYPES OF INTERACTING SPINS.

G.V.Skrotskii.

Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 793-4 (Sept., 1958).

In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 3, 550 (March, 1959).

A simple thermodynamic derivation is given of equations dealing with magnetization of a system consisting of two types of interacting magnetic moments and exhibiting spin–spin and spin–lattice relaxation. P.T.Landsberg

539.2 : 538.1

2977 SPIN WAVES. C.Kittel.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 19S (April, 1959).

No text is given.

539.2 : 538.2

2978 DIAMAGNETIC ANISOTROPY OF SYMM, $C_6H_3Br_3$, $C_6H_3Cl_3$ AND OF B–$B_3N_3H_3Cl_3$.

K.Lonsdale and E.W.Toor.

Acta cryst., Vol. 12, Pt 12, 1048 (Dec., 1959).

539.2 : 538.2

2979 THE MAGNETIC SUSCEPTIBILITY OF DEFECT ELECTRONS IN Si AND Ge. D.Geist.

Z. Phys., Vol. 157, No. 4, 490-8 (1960). In German.

For semiconductors, it is possible to determine the contribution of the free carriers to the magnetic susceptibility. Holes in silicon (density 10^{18} to 10^{19} cm^{-3}) have at 297° and 141°K a small paramagnetic susceptibility. In contrast, one computes from cyclotron mass parameters for 4°K a strong diamagnetic susceptibility. Holes in germanium (density 4×10^{17} and 4×10^{18} cm^{-3}) have a diamagnetic susceptibility, which is much smaller than one would expect from cyclotron resonance masses. Neutral boron atoms contribute in small concentration at 141°K to the susceptibility.

539.2 : 538.2

2980 SUPERPARAMAGNETISM, NONRANDOMNESS, AND IRRADIATION EFFECTS IN Cu–Ni ALLOYS.

R.M.Ryan, E.W.Pugh and R.Smoluchowski.

Phys. Rev., Vol. 116, No. 5, 1106-12 (Dec. 1, 1959).

The effect of neutron irradiation on Cu–Ni alloys was investigated by means of magnetic susceptibility measurements. The susceptibilities were measured by the Gouy method between 300° and 2.0°K for a series of alloys ranging from 17.22 to 46.5 atomic % nickel. It is shown that without superparamagnetism an unreasonable magnetic moment per nickel atom has to be assumed. This model is confirmed by irradiation studies in which samples were exposed to neutron fluxes at the Brookhaven reactor, ranging up to 2.2×10^{19} neutrons/cm^2 while at 80°C, and the magnetic susceptibilities were found to increase following the irradiation. The increase was easily observable due to its strong temperature dependence, and was greatest for the samples with the highest nickel content and for samples exposed to the highest neutron fluxes. The susceptibilities of the alloys returned to their original values following an anneal in or above the temperature range where self-diffusion becomes important, while no changes in the susceptibilities were observed following anneals at lower temperatures. It is suggested that the Cu–Ni system is not a perfect random solid solution but tends toward segregation, and that the neutron irradiation enhances diffusion toward a true equilibrium at room temperature. This is in agreement with several other observations.

539.2 : 538.2

2981 INTERPRETATION OF MAGNETIC PROPERTIES OF DYSPROSIUM.

S.H.Liu, D.R.Behrendt, S.Legvold and R.H.Good, Jr.

Phys. Rev., Vol. 116, No. 6, 1464-8 (Dec. 15, 1959).

Dysprosium is ferromagnetic below 85°K, antiferromagnetic between 85 and 179°K, and paramagnetic above 179°K. The spontaneous magnetic moment lies always in the basal plane, and there is anisotropy in this plane below 110°K. It is shown that the magnetic properties can be interpreted in terms of a two-sublattice model and a phenomenological theory similar to that proposed by Néel (Abstr. 5213-14 of 1956). Detailed agreement for the magnetization curves in the ferromagnetic regions is obtained.

539.2 : 538.2

2982 MAGNETIC DOUBLE REFRACTION OF MICROWAVES IN PARAMAGNETICS.

F.S.Imamutdinov, N.N.Neprimerov and L.Ya.Shekun.

Zh. eksper. teor. Fiz., Vol.34, No.4, 1019-21 (April, 1958).

In Russian. English translation in: Soviet Physics–JETP (New York), Vol.34(7), No.4, 704-5 (Oct., 1958).

Measurements of the rotation of the plane of polarization of 9375 Mc/s microwaves in hydrated manganese chloride are reported for transverse fields up to 16 kOe. A brief theoretical discussion of the results is given. A.J.Manuel

539.2 : 538.2

2983 SOME PROBLEMS OF PHENOMENOLOGICAL THEORY OF FERRO- AND ANTIFERROMAGNETISM.

S.V.Vonsovsky and E.A.Turov.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 9S-19S (April, 1959).

Presents a general review of the modern state of phenomenological theory of ferro- and antiferromagnetism and the results of some investigations in this field.

539.2 : 538.2

2984 THEORY OF SPIN-WAVE INTERACTIONS IN FERRO- AND ANTIFERROMAGNETISM. T.Oguchi.

Phys. Rev., Vol. 117, No. 1, 117-23 (Jan. 1, 1960).

The spin wave theory in an ideal Heisenberg model of a ferromagnet is studied using Holstein and Primakoff's method (Abstr. 891 of 1940) including the spin-wave interactions. Several earlier published results of the correction to the spontaneous magnetization produced by spin-wave interactions were in disagreement with each other, and they were not in agreement with Dyson's result (Abstr. 5998-9 of 1956) which is regarded as rigorous at low temperatures. The present result is in agreement with Dyson's to the order considered. The method can readily be applied to antiferromagnetism. The correction arising from interactions between spin-waves has been obtained, and is quite small. This means that the simple theory neglecting the spin-wave interactions is sufficient for practical purposes.

539.2 : 538.2

2985 **TEST OF SPIN-WAVE THEORY WITH PRECISION MAGNETIZATION MEASUREMENTS.**

S.Foner and E.D.Thompson.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 229S-230S (April, 1959).

Magnetic moment measurements of single crystal nickel, made from 4.2° to 290° K in a uniform magnetizing field applied along principal crystallographic directions, are presented. The precision of the measurements permits accurate comparison with predictions of spin-wave theory. At low temperatures (less than 150° K) $\Delta\sigma \propto T^{1.5 \pm 0.1}$ in agreement with spin-wave theory. Deviations from the $T^{1.5}$ law, observed at high temperatures, are much larger than predicted by high-order terms of spin-wave theory. Possible sources for the effect, including temperature variation of g value and/or exchange constant, are summarized. Estimates of exchange constant are given.

539.2 : 538.2

2986 **SATURATION MAGNETIZATION AND FERROMAGNETIC INTERACTION IN TERBIUM METAL.** W.E.Henry.

J. appl. Phys., Supplement to: Vol.30, No.4, 99S-100S (April,1959).

The magnetic moment of terbium metal has been directly measured at 295, 100, 4.2, and 1.25° K in applied magnetic fields up to 70 000 G. In the liquid helium range, $(\partial M/\partial T)_H$ is zero. Between 35 000 and 70 000 G, $(\partial M/\partial H)_T = (\alpha\beta^2/\Delta E) = 1.04 \times 10^{-3}$ Bohr magneton per atom per gauss for 100° K and for the liquid helium range. At 1.25° K and 70 000 G the magnetization is 7.5 Bohr magnetons per atom of terbium. This is perhaps near saturation. At 295° K the magnetization is linear up to about 45 000 G and shows a slight beginning saturation at higher fields. At 60 000 G the magnetization is 1.53 Bohr magnetons per atom of terbium. From the magnetization curve at 295° K (in the paramagnetic range) and a Brillouin function for the terbium atom in the $^7F_6$ ground state, a molecular exchange field of 700 000 G is calculated. A sample motion ballistic technique is used to measure magnetic moments.

539.2 : 538.2

2987 **INFLUENCE OF VARIOUS HEAT EXPOSURES ON ALNICO V MAGNETS.** R.K.Tenzer.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 115S-116S (April, 1959).

Alnico V magnets were exposed to temperatures between 350 and 550° C for as long as 1000 hours. Remanence was determined at room temperature intermittently during the exposures. The changes in remanence appeared to be caused by metallurgical as well as magnetic processes. The two effects were separated and it was found that the Alnico V material responds to temperatures as low as 350° C.

539.2 : 538.2

2988 **CURIE TEMPERATURE PREDICTION FOR SEVERAL LATTICE SPECIES.** G.Fournet.

J. Phys. Radium, Vol. 18, No. 12, 663-71 (Dec., 1957). In French.

It is possible to find the Curie temperature for several lattice species from the cooperative phenomena theory of Yvon. The values found seem to be the best approximate values that have been obtained.

539.2 : 538.2 : 621.318.132

2989 **EFFECTS OF HIGH TEMPERATURE ON MAGNETIC PROPERTIES OF CORE MATERIALS.**

M.Pasnak and R.H.Lundsten.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 107S-108S (April, 1959).

An experimental study was made of the effects of temperature on the d.c. and 60 c/s magnetic properties of the following alloys: Orthonol, 4-79 Mo Permalloy, AEM 4750, L and Z Silectron, Transformer A, Audio Transformer A, 11.7 Alfenol, 15.5 Alfenol, Thermenol, 7-70 Perminvar, and Supermendur. The results indicate that, in general, an increase in temperature decreases the coercive force and the maximum and residual inductions. Maximum and initial permeabilities increase with increasing temperature until the Curie temperature is approached, then they decrease. The initial permeability generally reaches a maximum at a lower temperature than does the maximum permeability.

539.2 : 538.2

2990 **TEMPERATURE DEPENDENCE OF THE MAGNETIC PROPERTIES OF NICKEL-IRON ALLOYS.**

J.J.Clark and J.F.Fritz.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 105S-107S (April, 1959).

The effect of temperature on the magnetic properties of six commercially available nickel-iron alloys is reported for the temperature range −60° to +250° C. The trade names of the alloys are: Hipernik, Deltamax, Hipernik V, Supermalloy, 4-79 Mo-Permalloy, and Hymu 80. The temperature dependence of both a.c. and d.c. magnetic properties was determined experimentally over the temperature range. D.C. properties were measured by the standard ballistic testing method. At each test temperature sufficient data was taken to plot a normal magnetization curve. Remanent induction and coercive force were also determined at each temperature, these properties being measured relative to magnetizing forces in excess of 100 Oe. A.C. properties were measured by means of a modified Hay bridge, the tests being conducted at frequencies of 60, 400, and 1000 c/s. At each test temperature, and for each frequency, total core loss was measured at various inductions in the range characteristic of the alloy being tested. The data presented are the average of the results of tests on six samples of each alloy.

539.2 : 538.27

2991 **EXPERIMENTAL DETERMINATION OF THE HYPERFINE COUPLING IN FERROMAGNETIC METALS AND ALLOYS.** N.Kurti.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 215S-219S (April, 1959).

Method for the experimental determination of hyperfine coupling in ferromagnetics based on specific heat measurements and on the observation of anisotropic γ emission are described. The results for cobalt, cobalt-nickel, and cobalt-iron alloys are presented and discussed in the light of recent ideas about the electronic structures of these ferromagnetic metals and alloys. The hyperfine coupling in metallic terbium is found to be nearly the same as for Tb^{3+} in terbium ethyl sulphate, a small difference being tentatively attributed to a difference in the 4f orbit radii in the two cases.

539.2 : 538.2

2992 **ANISOTROPY CONSTANTS OF IRON AND IRON-SILICON ALLOYS AT ROOM TEMPERATURE AND BELOW.** C.D.Graham, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 317S (April, 1959).

The magnetocrystalline anisotropy constants of iron and of alloys of 3.1 and 5.1% silicon in iron have been determined at 77, 195, and 300° K from torque measurements on single crystal disks in fields up to at least 15 000 Oe.

539.2 : 538.2

2993 **PRECIPITATION IN A BETA-BRASS-Fe ALLOY.** A.E.Berkowitz and P.J.Flanders.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 111S-112S (April, 1959).

Single crystal samples of beta-brass containing 0.1% iron were annealed at 300 and 400° C in order to develop the iron precipitate particles. At intervals during the anneals, magnetic data were obtained and analysed in terms of the size, shape, orientation, and general magnetic behaviour of the precipitate particles. During the earliest annealing stages, superparamagnetic behaviour was observed, and particle diameters were calculated from the Langevin relation. On continued annealing the magnetic properties indicated the presence of mixtures of superparamagnetic and single domain particles, and subsequently mixtures of single domain and multidomain particles. Torque curves showed that the particles were single crystals, with iron-like magnetocrystalline anisotropy oriented with the same crystal habit as the matrix. Single domain behaviour was first observed when the particle diameters were of the order of 200 A. Elongation of the particles in the ⟨111⟩ directions and rotational hysteresis were noted when single domain behaviour appeared. The magnetocrystalline anisotropy coefficients calculated from the torque data were reasonably close to those of iron. Maximum remanence was reached before maximum coercive force due to the much larger initial susceptibility of the superparamagnetic as compared to the multidomain particles. This was confirmed by the shapes of the hysteresis loops for the various cases.

539.2 : 538.2

2994 **RADIATION EFFECTS ON THE ANISOTROPY AND MAGNETOSTRICTION OF SINGLE CRYSTALS OF SEVERAL SOFT MAGNETIC MATERIALS INCLUDING Ni, Fe, Fe_3O_4, AND ALLOYS OF Ni-Fe, Si-Fe, Al-Fe, Co-Fe, AND Mo-Ni-Fe.** R.C.Hall, W.S.Byrnes and R.G.Crawford.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 288S-289S (April, 1959).

Single crystals of iron, nickel, nickel-iron, silicon-iron, aluminium-iron, cobalt-iron, cobalt-nickel, molybdenum-nickel-iron,

molybdenum-aluminium-iron, and nickel-cobalt-iron alloys and magnetite were tested for anisotropy and magnetostriction before and after irradiation in a nuclear pile. The dosage was 1.7×10^{20} total neutrons per square centimetre at about 50° C. The anisotropy of iron, nickel, silicon-iron alloys, and low-aluminium iron alloys did not change as a result of the irradiation. Crystals in order-disorder systems including nickel-iron, cobalt-iron and high-aluminium iron alloys showed variations in anisotropy often corresponding to a decrease in order. The irradiation did change the saturation magnetostriction in the [100] and [111] crystallographic directions in many of the single crystals. Frequently these variations could be attributed to a change in the state of order. However, for some of the alloys, notably the high-aluminium iron crystals, an increase in order would be required to explain the magnetostriction data while a decrease in order would be required for the anisotropy data. Consequently, a mechanism in addition to changes in the degree of order must alter magnetic properties of soft magnetic materials as a result of neutron bombardment.

539.2 : 538.2

2995 DIRECTIONAL ORDER AND DIFFUSION AFTER-EFFECT. L.Néel.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 3S-8S (April, 1959).

If an anisotropic local atomic configuration is produced in some way or other, the magnetization is stabilized in a direction related to this anisotropy, causing an additional uniaxial magnetic anisotropy. This kind of an anisotropy in the atomic configuration is called a directional ordering. This may be an anisotropic distribution of constituent atoms in substitutional ferromagnetic alloys, of interstitial atoms in a body centred cubic lattice, or of different atoms or ions on the B sites of mixed ferrites, etc. A brief explanation of the phenomena is given in each case. Also because of the coupling between the atomic arrangement and the direction of the magnetization, a relaxation phenomenon may be observed in the magnetization process which depends on the diffusion of atoms. The magnetic after-effect arising from a small amount of carbon in α-iron is explained in detail.

539.2 : 538.2

2996 EXCHANGE ANISOTROPY IN DISORDERED Ni_3Mn. J.S.Kouvel and C.D.Graham, Jr.

J. appl. Phys., Supplement to: Vol.30, No.4, 312S-313S (April, 1959).

Magnetic hysteresis loop and torque measurements were made on a disordered polycrystalline Ni_3Mn specimen which had been cooled to liquid helium temperatures in a magnetic field. The hysteresis loop measured parallel to this field was shifted from its symmetrical position about the origin. The torque curves indicated a single direction (rather than axis) of easy magnetization and revealed a rotational hysteresis which continued to increase up to the highest field of measurement (8000 Oe). It is concluded that the coexistence of ferromagnetism and antiferromagnetism at low temperatures in these alloys, as previously reported, gives rise to exchange anisotropy interactions of the type conceived by Meiklejohn and Bean for the ferromagnetic Co-antiferromagnetic CoO system. However, important differences in detail between disordered Ni_3Mn and the Co-CoO system are suggested by the experimental results.

539.2 : 538.2

2997 EXCHANGE ANISOTROPY IN AN IRON-ALUMINUM ALLOY. J.S.Kouvel.

J. appl. Phys., Supplement to: Vol.30, No.4, 313S-314S (April, 1959).

Magnetic hysteresis loop and torque measurements were made on a polycrystalline Fe-Al alloy specimen, of 30 atomic percent Al and FeAl-type order, which had been cooled to 1.8° K in a magnetic field. The hysteresis loop measured parallel to this field was found to be asymmetrical with respect to the origin and considerably "squared up" as compared to the loop for zero field applied during cooling. The torque curves had large $\sin\Psi$ and somewhat smaller $\sin 2\Psi$ components; the rotational hysteresis, though decreasing with increasing field, was still appreciable at 8000 Oe. The mechanism for these effects is believed to be an exchange anisotropy arising from a coexistence of ferromagnetism and antiferromagnetism in this Fe-Al alloy. However, the experimental results indicate significant deviations from the simple exchange anisotropy model originally proposed for the Co-CoO system.

539.2 : 538.2

2998 ON THE MAGNETIC ANISOTROPY IN MANGANESE-IRON SPINELS. R.F.Penoyer and M.W.Shafer.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 315S-316S (April, 1959).

The magnetic anisotropy energy is measured as a function of temperature in eleven single crystal compositions corresponding to $Mn_xFe_{3-x}O_4$, where x is varied from 0.00 to 1.90. The interesting features observed are as follows. (1) Small manganese concentrations in magnetite (x = 0) are shown to decrease the temperature of the "isotropy point" known to exist in magnetite at low temperatures. (2) An unexpected variation in the temperature dependence and magnitude of the anisotropy energy in the x = 0.4 to 1.0 composition region is shown. (3) The anisotropy energy in the composition region between x = 1.0 and 1.3 is semiquantitatively shown to be related to cubic crystalline field splitting of the energy levels of ferric ions. (4) A large planar anisotropy is measured in a crystal composition given by x = 1.90 and is discussed in terms of the expected tetragonal nature of trivalent manganese. (5) Finally, a minute magnetic annealing effect at a temperature of 370° K has been shown to exist in a crystal composition corresponding to x = 0.40 and the magnitude of this effect is shown to be dependent on the direction relative to the crystal axes of the applied magnetic field during the annealing process.

539.2 : 538.2

2999 ANISOTROPY OF SUPERPARAMAGNETIC PARTICLES AS MEASURED BY TORQUE AND RESONANCE. J.D.Livingston and C.P.Bean.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 318S-319S (April, 1959).

Simple statistical reasoning has been applied to the case of an assembly of crystallographically aligned superparamagnetic particles at a given field and temperature. The apparent magnetocrystalline anisotropy as measured both by torque and resonance has been deduced for the cases of uniaxial and cubic anisotropies. Certain features of recent experimental results on precipitated cobalt particles can be explained, including the observation that, at high temperatures, the anisotropy measured by resonance is greater than that measured by torque.

539.2 : 538.2

3000 STONER-WOHLFARTH CALCULATION ON PARTICLE WITH BOTH MAGNETOCRYSTALLINE AND SHAPE ANISOTROPY. C.E.Johnson, Jr and W.F.Brown, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 320S-322S (April, 1959).

Previously, it had been assumed that the presence of a minimum of magnetocrystalline anisotropy energy along the long axis of an acicular single-domain particle would increase the coercive force. A theoretical calculation using the Stoner-Wohlfarth model with a magnetocrystalline energy term indicates this is not always true. For an acicular polycrystalline single-domain particle with cubic magnetocrystalline anisotropy, it is assumed that the crystallites are ordered with the [111] direction parallel to the long axis, and the other directions randomly oriented around this [111] direction. Carrying out the Stoner-Wohlfarth calculation with various ratios of magnetocrystalline anisotropy to shape anisotropy shows the presence of certain stable states of magnetization which are inaccessible by merely traversing the hysteresis loop. Also, the coercive force of a random agglomerate is related in a complex way to the anisotropy ratio (ratio of crystalline to shape anisotropy constants), becoming zero for large values of the anisotropy ratio. "Butterfly" hysteresis loops also appear for a wide range of anisotropy ratios.

539.2 : 538.2

3001 PSEUDODIPOLAR ANISOTROPY IN CUBIC FERROMAGNETS AT LOW TEMPERATURES. S.H.Charap and P.R.Weiss.

Phys. Rev., Vol. 116, No. 6, 1372-80 (Dec. 15, 1959).

The first-order anisotropy constant, K_1, of a cubic ferromagnet with spin 1/2 per atom is calculated as a function of temperature at low temperatures. The source of this anisotropy is taken to be the nearest neighbour pseudodipolar spin–spin interaction and the spin-wave approach of Dyson is used. It is shown that K_1 varies as the tenth power of the magnetization, itself a function of the temperature. In order to explain the experimental value of K_1 for nickel at T = 0 the strength of the dipolar interaction must be ~ 300 times the classical value. Previous calculations by Van Vleck, Van Peipe, and Tessman are compared with the present work on the ground state. Only the work of Van Peipe accounts properly for the exchange and is in complete agreement with the present investigation. The perturbation scheme of Van Peipe is shown to be rigorously correct, the wave-function converging to an exponential form.

539.2 : 538.2

3002 MAGNETIC PROPERTIES OF MAGNETO-ANISOTROPIC SPECIMENS COMPOSED OF FERROMAGNETIC POWDERS. III. ANISOTROPY OF THE MAGNETIC PROPERTIES. G.S.Kandaurova, Ya.S.Shur and E.V.Shtol'ts. Fiz. Metallov i Metallovedenie, Vol. 6, No. 2, 229-36 (1958). In Russian.

For Pts I and II, see Abstr. 417-18 (1959). A study of the anisotropy of the curves of magnetization and the hysteresis loop of magneto-granular specimens in the form of discs made of powders of (1) cobalt, and (2) the alloy Mn–Bi. The powdered Co was obtained by grinding down a piece of cast Co, and then subjecting it to heat treatment in vacuo at 600° C. The alloy Mn–Bi was obtained by sintering mixtures of powdered Mn and Bi at 320° C. The product was then ground down to a powder, without any heat treatment. The results are exhibited not in tables, but in the following curves: for MnBi (1) curves of magnetization showing I/I_s plotted against H, for three directions of magnetization making angles $\phi = 0°$, 60° and 90° with the grain axis. (2) Curves showing the anisotropy of the coercive force for five sizes of grain and for various values of ϕ from 0° to 180°, in polar coordinates. (3) Curves showing the anisotropy of the coercive force in the directions $\phi = 0$ and $\phi = 90°$, for a range of grain diameters 0-250 μ. (4) Curves showing the anisotropy of the residual magnetic intensity of powders of various grain sizes. (5) Hysteresis loops, showing I/I_s plotted against H for directions $\phi = 0°$, 60° and 90°. For cobalt, curves of the types (1) to (4) inclusive but not (5) are shown. The results are analysed in a partly quantitative manner. A simple theory of the magnetic energy in a powder is given, and tested by two pairs of graphs, showing theoretical and experimental values of the coercive force and intensity of magnetization, for powders of Mn–Bi of grain diameter 4 μ. The final deduction made is that in fine powders (1-10 μ) of Mn–Bi, there is a transitional magnetic structure between a single and a multi-domain structure explained thus. In directions near the grain axis of the specimens a cycle of magnetization involves neither a rotation of domains nor a movement of domain boundaries. The basic role is here played by a hysteresis of the formation and growth of nuclei of cyclic magnetization. In directions remote from the grain-axis, rotation of the domains is the principal factor in the process of magnetization. In fine powders of Co, of the same size (1-10 μ), a multi-domain structure is still observed. This is due to the fact that the anisotropy constant of Co is much smaller than that of Mn–Bi, and hence also the critical grain diameter, at which Co changes to a single domain structure, is less than that of Mn–Bi. N.Davy

539.2 : 538.2

3003 SOME RECENT DEVELOPMENTS IN MICROMAGNETICS AT THE WEIZMANN INSTITUTE OF SCIENCE. A.Aharoni.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 70S-78S (April, 1959).

Recent theoretical studies carried out in micromagnetics at this Institute are reviewed, and preliminary results are given for theoretical problems which are now under study. The coercive force of an infinite circular cylinder is calculated as a function of the radius and of the inclination of the cylindrical axis to the applied field, assuming that only the curling and the rotation in unison modes take place; and that whenever the curling is associated with a discontinuous jump, the magnetization is brought to the values tabulated by Stoner and Wohlfarth, who assumed only rotation in unison. Also the rotational hysteresis loss and integral are calculated both for an aligned and for a random assembly of cylinders. The results are found to be in fair agreement with the measurements of Jacobs and Luborsky on elongated particles. The remanence curves of a random assembly of infinite cylinders are calculated for the same model as a function of the applied field and of the radius of the cylinders. The rotation in unison and the curling are proved to be the easiest modes for magnetization reversal in a ferromagnetic sphere. As an attempt to introduce interparticle interactions the following model is treated. A square lattice of infinite cylinders with a square cross-section is assumed with all cylinders parallel to the applied field. Rotation in unison of the spins is assumed for each column of cylinders, and rotation in opposite directions but with equal magnitudes of the angle is assumed for neighbouring columns. The coercive force of this model is found to be only slightly less than that given by Néel's formula which is valid for coherent rotation in a random distribution of infinite cylinders of any cross-section. A first approach to the study of the dependence of coercive force on imperfections is carried out by treating each of two mathematical models for a material which is infinite in all directions. The first model is a slab of finite width in which the anisotropy constant K is zero. The second one one is a linear reduction of K through a slab of finite width from its constant value to zero.

539.2 : 538.2

3004 THEORETICAL APPROACH TO THE ASYMMETRICAL MAGNETIZATION CURVE. A.Aharoni, E.H.Frei and S.Shtrikman.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 79S (April, 1959).

The method previously used to calculate the magnetization curve of an infinite ferromagnetic cylinder is applied to the new Meiklejohn and Bean material which is made of Co particles in a CoO shell. For this calculation it is assumed that the interface of the ferromagnetic and antiferromagnetic materials is held parallel to the cylindrical axis and does not change its direction for any value of the applied field. The crystal anisotropy is neglected throughout the calculation. The nucleation field is calculated, and it is found that the easiest nucleation mode for small radii is buckling and for large radii is curling. The transition from buckling to curling is at about $RI_sA^{-1/2} = 2$. Here R is the radius of the cylinder, I_s is the saturation magnetization, and A is the exchange constant. The calculation of the hysteresis curve for the curling mode involves the solution of a nonlinear differential equation. A similar calculation of the magnetization curve is carried out for an infinite slab with the spins on the surface held at a fixed direction and with the crystal anisotropy neglected. In the two cases considered the coercive force is approximately equal to the nucleation field. This coercive force is found to agree with the experimental one for a radius of 220 A for the cylinder, or a width of 270 A for the slab.

539.2 : 538.2

3005 ANGULAR VARIATION OF THE COERCIVITY OF PARTIALLY ALIGNED ELONGATED FERROMAGNETIC PARTICLES. E.P.Wohlfarth.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 117S-119S (April, 1959).

The angular variation is considered for a number of models assuming coherent or incoherent magnetization reversals, and some application is made to experimental data.

539.2 : 538.2

3006 SOME MAGNETIC PROPERTIES OF THE CHROMIUM (III) HALIDES AT 4.2° K. W.N.Hansen.

J. appl. Phys., Supplement to: Vol.30, No.4, 304S-305S (April, 1959).

Magnetization curves for CrF_3, $CrBr_3$, and CrI_3 at 4.2° K have been determined for fields up to 16 kG. CrF_3 exhibits hysteresis with a remanent moment of 0.04 Bohr magneton, and a saturation moment of about 0.1. CrF_3 is evidently ferrimagnetic. $CrBr_3$ exhibits no hysteresis, and below 350 G the magnetization is strictly linear with field. CrI_3 exhibits pronounced hysteresis not fully developed at 16 kG. The expected saturation moment of 3 Bohr magnetons is compatible with the curves for CrB_3 and CrI_3.

539.2 : 538.2

3007 EFFECT OF NEUTRON IRRADIATION OF THE MAGNETIC PROPERTIES AND DEGREE OF ORDER OF MAGNETIC METAL ALLOYS. A.I.Schindler, E.I.Salkovitz and G.S.Ansell.

J. appl. Phys., Supplement to : Vol. 30, No. 4, 282S-283S (April, 1959).

Sixty-cycle sine current hysteresis loops have been made on thermally treated Permalloy type material both prior to and following neutron irradiation. In all cases the hysteresis loops of the irradiated alloys resembled the constricted loops characteristic of partially ordered Ni_3Fe. The effect of the sample temperature during irradiation on the magnetic properties suggests that ordering results from diffusion of vacancies.

539.2 : 538.2

3008 REDUCTION OF SATURATION MAGNETIZATION OF γ-Fe_2O_3 AND Fe_3O_4 BY PILE IRRADIATION. W.E.Henry and E.I.Salkovitz.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 286S-287S (April, 1959).

Through measurements of the magnetization as a function of magnetic field at 4.2° K, the absolute saturation magnetization has been obtained for γ-Fe_2O_3 and Fe_3O_4 before and after irradiation in the Brookhaven Pile. The reduction in saturation magnetization amounted to 3% and 15%, respectively for gamma iron oxide (III) and magnetite. A sample motion ballistic method was used at liquid helium temperatures and in magnetic fields up to 60 000 G. The

reactor, operated at 14 MW for approximately one month, gave total fluxes of 5.4×10^{16} thermal neutrons per cm^2, 8.0×10^{17} epithermal neutrons, and 1.2×10^{17} fast neutrons per cm^2.

539.2 : 538.2

3009 MAGNETIC CONTRIBUTION TO THE ANOMALOUS γ-LOOP SHEAR OF Fe-Al ALLOYS.

R.Kikuchi and H.Sato.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 92S-94S (April, 1959).

The free energy of the Fe-Al system is calculated using the cluster-variation method of cooperative phenomena on the Ising-type scalar spin model under the assumptions that there are a direct positive (ferromagnetic) interaction between nearest neighbouring Fe atoms and an indirect negative (antiferromagnetic) superexchange interaction between a pair of Fe atoms which are separated by an Al atom. These assumptions were proved to be quite successful in explaining the magnetic properties over the enitre range of Fe-Al system. It is found that the magnetic free energy of the system can be lowered by adding Al atoms while the Curie point is also lowered. This kind of situation is required for explaining the anomalous upward shear of γ loop in Fe-Al system, but this type of conclusion cannot be obtained from the nearest neighbour interaction model or from the concept of the corresponding state.

539.2 : 538.2

3010 STRUCTURAL AND MAGNETIC PROPERTIES OF Mn-Co-C ALLOYS. A.H.Holtzman and G.P.Conrad, II.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 103S-104S (April, 1959).

$Mn_xCo_{(3-x)}C_{.2}$ alloys were studied for magnetic properties, crystal structure, and metallographic appearance. A superlattice having the stoichiometric composition Mn_3Co_3C was found to be markedly magnetic. The structure of this alloy is pseudo-f.c.c. with the C atom in the central $(\frac{1}{2}\frac{1}{2}\frac{1}{2})$ position, the Mn atoms in the (000) and $(\frac{1}{2}\frac{1}{2}0)$ sites, and the Co atoms in the $(0\frac{1}{2}\frac{1}{2})$ and $(\frac{1}{2}0\frac{1}{2})$ sites. A magnetic structure was deduced from a consideration of the effect of atomic separation on magnetic vector alignment and an indication that electrons transfer from the central C atom to its nearest neighbours, the face atoms.

539.2 : 538.2

3011 SPONTANEOUS MAGNETIZATIONS OF SOME GADOLINIUM ALLOYS. S.Arajs and D.S.Miller.

J. appl. Phys., Vol.31, No.1, 213-15 (Jan., 1960).

Reports results of an analysis of the spontaneous magnetization of alloys of Gd with 10.0, 16.7, 25.0 and 33.3% Y and 10.0% La (Abstr. 6042 of 1958). Deviations from the $T^{3/2}$ law occur at 90°, 80°, 70°, 60° and 120°K respectively; the respective Curie temperatures are 282°, 262°, 241°, 222° and 253°K. E.P Wohlfarth

539.2 : 538.2

3012 INVESTIGATION OF A PRECIPITATION HARDENING ELINVAR. F.C.Hawkes.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 206S-207S (April, 1959).

In a nickel-iron-chromium alloy of the Elinvar type containing 2.5% titanium, it is possible to retain the titanium in solid solution by a quench from 1000°C. Ageing at 600°C produces a nonmagnetic precipitate of an intermetallic compound (Ni_3Ti) dispersed throughout the ferromagnetic matrix. The precipitate can be detected by changes in mechanical and magnetic properties. The internal friction, Curie point, and coercive force were measured during the course of precipitation. The effect of ageing time and temperature, plastic deformation, and composition on Q was studied. Both continuous and discontinuous precipitation were observed. The decrease in strain-induced magnetostriction as a result of ageing in this alloy raised the elastic modulus and changed the shape of the modulus versus temperature curve below Curie point.

539.2 : 538.2

3013 COLLECTIVE ELECTRON FERROMAGNETISM. III. RELATIVE MAGNETIZATION OF FERROMAGNETIC ALLOYS. H.Watanabe.

J. Phys. Soc. Japan, Vol. 13, No. 2, 187-98 (Feb., 1958).

The relative magnetization (ζ_0) of ferromagnetic alloys composed of the first transition metals (except manganese) is studied at absolute zero. Based on Stoner's representation of the reduced inverse susceptibility versus reduced temperature curves, ζ_0 values are found from the measured values of saturation magnetization at absolute zero (σ_0), of the Curie temperature (θ) and of the mass susceptibilities above the Curie temperature (χ). With the estimated values of ζ_0, the number of carriers of ferromagnetism is plotted against the number of outer electrons. It is found from experiments on some body-centred cubic alloys of iron that ζ_0 is not much less than unity for these alloys, and hence it is concluded that for body-centred cubic alloys the lower half of the d band is not responsible for ferromagnetism. A similar analysis for face-centred cubic alloys shows that ζ_0 values of face-centred cubic cobalt-iron and nickel-iron alloys decrease gradually as the iron content increases, and the number of carriers of ferromagnetism becomes greater than 2 per atom near the composition of the body- and face-centred cubic boundary. Some other examinations are also made on the band theory of ferromagnetism in relation to the neutron diffraction experiments made by Shull and Wilkinson.

539.2 : 538.2

3014 REMARKS ON MAGNETICALLY DILUTE SYSTEMS. H.Sato, A.Arrott and R.Kikuchi.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 94S-96S (April, 1959).

Because of the inadequacies of previous treatments of the magnetic properties of magnetically dilute systems when used to interpret experimental results, a re-examination of the problem starting from a simple model is made. The treatments of the problem discussed here using an Ising model show that a Curie or a Néel temperature does not appear until a finite concentration of magnetic atoms is obtained if the atomic distribution is random. This concentration depends on the coordination number of the lattice and on the range of interaction, but not on the strength of the interaction. The results given here for nearest neighbour interactions describe the general behaviour observed in magnetically dilute solutions. Such things as anomalously high values of "effective magnetic moments" per magnetic atom and its concentration dependence, curvature in inverse susceptibility against temperature plots, and parasitic paramagnetism in the weakly ferromagnetic alloys, etc., are reasonably well explained. When the system has antiferromagnetic interactions, it is found that the inverse susceptibility shows a complicated temperature dependence varying with concentration and that the existence of a maximum in the susceptibility does not necessarily mean the onset of antiferromagnetism. Special references are made to iron in gold and chromium and to manganese in copper.

539.2 : 538.2

3015 SATURATION MAGNETIZATION AND CURIE POINTS IN DILUTE ALLOYS OF IRON. A.Arrott and J.E.Noakes.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 97S-98S (April, 1959).

A report of the initial stages of an investigation of the intrinsic properties of dilute alloys of iron is given. Methods of determining spontaneous magnetization and Curie temperatures with precision of one part in 30 000 are discussed. The results for Fe-Ti alloys are singled out for attention. The decrease of spontaneous magnetization at a rate of more than 1.6 times that of simple dilution implies either a negative moment on the Ti atoms or more probably that the occupation of states contributing to the moment on the iron is decreased by the addition of Ti. The increase in the Curie temperature at a rate of 3.7°C per atomic percent Ti is discussed on the basis of the Bethe–Slater curve of exchange interaction as a function of atomic separation.

539.2 : 538.2 : 539.219

3016 THE PARTICLE SIZE DEPENDENCE OF THE MAGNETIZATION OF SUPERPARAMAGNETIC COBALT PRECIPITATES IN Cu–Co ALLOYS. A.Knappwost.

Z. Elektrochem., Vol. 63, No. 8, 965-9 (1959). In German.

Reports results of magnetic measurements on Cu–Co alloys containing 0.75% Co precipitating at temperatures below 500°C. The measurements give values of the magnetization and volume of the precipitating particles with size down to about 10 A. After a correction, it was found that the magnetization is independent of size down to this value. E.P.Wohlfarth

539.2 : 538.2

3017 PECULIARITIES OF MAGNETIZATION OF DISORDERED Ni_3Mn ALLOY AT LOW TEMPERATURES.

N.V.Volkenshtein, M.I.Turchinskaya and É.V.Galoshina.

Zh. eksper. teor. Fiz., Vol.35, No.5(11), 1312-13 (Nov., 1958).

In Russian. English translation in: Soviet Physics–JETP (New York) Vol.35(8), No.5, 916-17 (May, 1959).

Experiment has shown that crystallographically disordered Ni_3Mn becomes ferromagnetic below 110°K. The coercive forces at 77.8°K and at 20.4°K are 140 Oe and 1000 Oe respectively. From

this and from the shape of the magnetization curves it is inferred that the magneto-crystalline anisotropy becomes very large at low temperatures. R.Parker

539.2 : 538.2

3018 SOME NEW MAGNETIC PHENOMENA OF HEMATITE SINGLE CRYSTAL. S.T.Lin.
J. appl. Phys., Supplement to: Vol.30, No.4, 306S-307S (April, 1959).

Three sets of magnetic measurements of pure natural hematite single crystals have been carried out in the temperature range from 488 to 4.2°K. The first set is the magnetization isotherms along a certain direction in the basal plane which show nothing new but confirm Neel's magnetic model of a superposition of a weak ferromagnetism on a normal antiferromagnetism. The second set is the isotherms along the ternary axis which display very unusual form. The analysis of the isotherms show: (1) that the antiferromagnetic susceptibility-temperature curves, $\chi-T$, are in good agreement with those obtained by Neel and Pauthenet, (2) that the spontaneous magnetization temperature curves, σ_0-T, indicate that there is no evidence of isotropic ferromagnetism, and that the weak anisotropic ferromagnetism in the basal plane above transition and along the ternary axis below transition seems to have the same nature and origin, (3) the wide transition over a hundred degrees takes place gradually and continuously. The third set of the magnetic measurements is the remanent magnetization along the ternary axis. The σ_R-T curve is very similar to the σ_0-T curve. A more general magnetic model has been proposed which explains the experimental data very satisfactorily. From the present model Haigh's data of remanent magnetization of hematite powder seems to be explained naturally. See also following abstract.

539.2 : 538.2

3019 MAGNETIC PROPERTIES OF HEMATITE SINGLE CRYSTALS. I. MAGNETIZATION ISOTHERMS, ANTIFERROMAGNETIC SUSCEPTIBILITY, AND WEAK FERROMAGNETISM OF A NATURAL CRYSTAL. S.T.Lin.
Phys. Rev., Vol.116, No.6, 1447-52 (Dec. 15, 1959).

Two sets of magnetization isotherms of pure natural hematite single crystals from Elba were obtained in the temperature range from 488°K down to liquid helium temperatures. The first set of curves, along a certain direction in the basal plane, support Néel's magnetic model of a superposition of a weak ferromagnetism on a normal antiferromagnetism. The second set of curves, along the ternary axis, display very unusual form. The analysis of the isotherms shows that the antiferromagnetic susceptibility–temperature curves $\chi-T$, are in good agreement with those obtained by Néel and Pauthenet but the weak ferromagnetic properties are apparently contradictory to their interpretations. The spontaneous magnetization–temperature curves, σ_0-T, indicate that there is no isotropic ferromagnetism, and that the weak anisotropic ferromagnetism in the basal plane above transition and along the ternary axis below transition seems to have the same nature and origin. The $\chi-T$ and σ_0-T curves show that the wide transition takes place gradually and continuously. A general magnetic model of canted antiferromagnetism with unequal sublattice moments is proposed which explains all the experimental data satisfactorily. From the present model Haigh's data on remanent magnetization of hematite powder seem to be explained naturally.

539.2 : 538.2

3020 SYNTHESIS OF A (110) [001] TYPE TORQUE CURVE IN SILICON IRON.
C.G.Dunn and J.L.Walter.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 320S (April, 1959)
See Abstr. 8875-6 (1959).

539.2 : 538.2

3021 THE INFLUENCE OF AN ALTERNATING MAGNETIC FIELD [OF VARYING MAXIMUM AMPLITUDE] ON THE REMANENT STATE OF MAGNETICALLY SOFT MATERIALS. V.Hajko and J.Daniel-Szabó.
Czech. J. Phys., Vol. 9, No. 1, 37-46 (1959). In Russian.

The apparent remanent state was studied of toroidal and open samples of metallic and non-metallic magnetically soft ferromagnetics. An interpretation of the corresponding dependences is given on the basis of Kondorski's conception of the composition of a polycrystalline ferromagnetic material.

539.2 : 538.2

3022 CORRELATION OF ENERGY LOSSES WITH PERFECTION OF CRYSTAL ORIENTATION AND DOMAIN STRUCTURE H.Hu and G.Wiener.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 86S-87S (April, 1959).

Hysteresis and core loss measurements were made on single crystal strips of 3% Si-Fe of the (110) [001] orientation, the commercial singly oriented material with a (110) [001] texture, and the doubly oriented material with a fair amount of (100) [001] cube texture. All these specimens had a thickness of 0.012 in., measured using an Epstein frame. The energy losses calculated on a domain model were compared with the experimental data. Results indicated that there is little correlation of the observed eddy-current losses with the proposed domain model, and that the energy losses may be strongly dependent on the perfection of crystal orientation.

539.2 : 538.2

3023 HYSTERESIS AND EDDY LOSSES IN SILICON IRON AS A FUNCTION OF SHEET THICKNESS. P.W.Neurath.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 88S-89S (April, 1959).

Pry and Bean have calculated energy losses in magnetic sheet materials using a simple domain model. A quantitative verification of these results for (110) [001] oriented 3.2% Si-Fe, varied in thickness from 13 to 2 mil has been attempted. Domain wall spacings were measured visually from static Bitter patterns and calculated from measured 60 c/s and d.c. hysteresis losses. It is pointed out that the calculated spacing must be the spacing between simultaneously moving walls and that this is several times as large as the visually observed one for the thin gauge sheets. At the thicker gauges, probably due to the skin effect, the discrepancy decreases.

539.2 : 538.2

3024 EFFECT OF MAGNETIC ANNEALING ON THE PROPERTIES OF (110) [001] ORIENTED 3¼% SILICON-IRON STRIP. H.C.Fiedler and R.H.Pry.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 109S-110S (April, 1959).

Polycrystalline 3¼% silicon-iron strip with (110) [001] texture was heat-treated in a magnetic field. Both a.c. and d.c. properties were investigated before and after magnetic annealing with the field parallel to the ⟨100⟩, ⟨110⟩, and ⟨111⟩ directions. Distinct improvement in properties was obtained, particularly in the ⟨110⟩ and ⟨111⟩ directions. This improvement is the result of the realignment of domain boundaries to ⟨100⟩ directions that more nearly coincide with the direction of the applied field. The anisotropy energy that arises from the magnetic annealing is about 900 erg/cm³, which is but a small fraction of the magnetocrystalline anisotropy energy of this material.

539.2 : 538.2

3025 THE INFLUENCE OF STRESSES ON THE TRANSVERSE MAGNETIZATION OF EVAPORATED NICKEL FILMS.
W.Hellenthal.
Z. Phys., Vol. 156, No. 4, 573-81 (1959). In German.

The magnetization curves for fields applied normal to the planes of the films have been studied by the Hall and Faraday effects. From the variation of the form of the curves with temperature and substrate, it is suggested that the occurrence of saturation in applied fields lower than the theoretical demagnetizing fields may be explained by the presence of stresses. A.J.Manuel

539.2 : 538.2

3026 BARKHAUSEN EFFECT IN NICKEL-IRON FILMS.
N.C.Ford, Jr and E.W.Pugh.
J. appl. Phys., Supplement to : Vol. 30, No. 4, 270S-271S (April, 1959).

A statistical study of Barkhausen discontinuities in nickel-iron films has been made by observing independent hysteresis loops obtained from different areas of each film. The magnetization changes were detected by photomultiplier sensing of the light output from a standard Kerr magneto-optical apparatus. Observations could thus be restricted to any desired region of the film by suitably varying the light spot size and location. The sequence of Barkhausen discontinuities in a given reversal is generally random and cannot be predicted by the sequence in a previous reversal. The statistical distribution of discontinuity sizes obtained from many reversals is shown to be well described by a simple model of wall motion in which the probability of a wall stopping in an interval of distance dx is proportional to dx. The applicability of this model to bulk materials is discussed.

539.2 : 538.2

3027 THE REVERSAL OF SPIN VECTORS IN MAGNETICALLY CHARGED 180° DOMAIN WALLS. C.Greiner.
Ann. Phys. (Leipzig), Folge 7, Vol. 5, No. 1-2, 57-69 (1959). In German.

Considers the problem of the magnetization reversals for 180° walls under the influence of uniaxial anisotropy, exchange and magnetostatic forces, the last arising from plane magnetic pole distributions. These distributions, the wall energy and thickness are calculated. E.P.Wohlfarth

539.2 : 538.2

3028 MICROMAGNETICS, DOMAINS, AND RESONANCE. W.F.Brown, Jr.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 62S-69S (April, 1959).

Current domain theory is based largely on the wall concept and on the 1935 paper of Landau and Lifshitz, which contained the germ of another theory; the basic concept of a spontaneous magnetization whose direction varies continuously with position. This approach, micromagnetics, can in principle yield a complete, self-consistent theory, from which the domain wall concepts when valid will emerge naturally, without having to be postulated. The present paper summarizes the history, accomplishments, and possibilities of such a theory. The basic partial differential equations of the theory are nonlinear; they have been attacked by four methods: (1) Study of one-dimensional cases formed the basis of traditional domain theory and of other early work; (2) Linearization of the equations proved possible in the study of the approach to saturation; (3) The Ritz method has been used in the study of fine particles and of films; (4) Numerical calculations with electronic computers have been made in some nonlinear cases. The single-domain problem, in certain of its aspects, has been rigorously solved by use of linear equations. The equilibrium equations of micromagnetostatics are closely related to dynamic equations used in the theory of ferromagnetic resonance and of spin waves.

539.2 : 538.2

3029 DOMAIN BOUNDARY CONFIGURATIONS DURING MAGNETIZATION REVERSALS. J.J.Becker.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 79S (April, 1959).
See Abstr. 7162 of 1959.

539.2 : 538.2

3030 ENERGY LOSS RESULTING FROM DOMAIN WALL MOTION. W.J.Carr, Jr.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 90S-91S (April, 1959).

At low frequencies the fraction of domain walls moving at a given instant is small; at higher frequencies all the walls move. Therefore, as the frequency approaches zero the eddy current constant becomes larger. The calculations of Pry and Bean are shown to pertain to the higher frequency case. It is also pointed out that the hysteresis loss should not be the lower limit of the loss versus frequency curve as usually measured.

539.2 : 538.2

3031 NUCLEATION OF FERROMAGNETIC DOMAINS IN IRON WHISKERS. R.W.DeBlois and C.P.Bean.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 225S-226S (April, 1959).

Nucleation fields up to 483 Oe have been experimentally observed for the reversal of magnetization in regions of nearly perfect iron whiskers about 5 μ thick. This is near the theoretical limit $2K_1/M_s$ (= 560 Oe for iron) for the coercive force resulting from magnetocrystalline anisotropy. In addition, conspicuous growth defects on the surface are observed to be sites of easy nucleation. A field of about one oersted, if applied to the damaged end of an iron whisker of this size, suffices to reverse the magnetization by domain wall motion.

539.2 : 538.2

3032 A CONTRIBUTION TO THE DOMAIN STRUCTURE OF IRON WHISKERS. J.Kaczér and R.Gemperle.
Czech. J. Phys., Vol. 9, No. 3, 306-13 (1959).

An interpretation of the domain patterns. An explanation of the closure structure at the end of a whisker grown in the [111] direction is given on the basis of a quantitative analysis. Structures, which form on whiskers strained by axial pressure and bending, are also dealt with. The results are in good agreement with experiment.

539.2 : 538.2

3033 THE ENERGY OF PERIODIC SURFACE STRUCTURES IN FERROMAGNETISM. L.Špaček.
Czech. J. Phys., Vol. 9, No. 2, 186-99 (1959).

The periodic domain structures on unfavourably oriented surface layers of ferromagnetic materials were studied both experimentally and theoretically. The connection between the surface structure and the crystallographic orientation of the crystals was confirmed. All the terms contributing to the total energy of the surface layer were calculated. A general solution of the potential problem is given for arbitrary periodic distribution of the charges.

539.2 : 538.2

3034 THE SURFACE LAYER ON A FERROMAGNETIC. THE ENERGY OF SOME PERIODIC DOMAIN STRUCTURES. L.Špaček.
Czech. J. Phys., Vol 9, No. 2, 200-14 (1959).

Explicit solutions are found for a number of special cases of the potential problem of periodic charge distribution. The effect of uneven distribution of the charges of a Bloch wall on the magnetostatic energy is studied, the effective width of the Bloch wall is determined, an analytical expression is found for this distribution of poles, and the effective height of the surface layer is also determined. An expression is derived for the orientation of the vectors of magnetization in the surface layer with respect to the easy directions of magnetization. The stability of the basic domain structure up to an inclination of 6° of the plane under observation to the direction of easy magnetization and the dimensions of the domains in periodic closure structures follow from the calculations.

539.2 : 538.2

3035 DOMAIN PATTERN MOVEMENTS IN SILICON-IRON OBSERVED BY ELECTRON MIRROR MICROSCOPY. L.Mayer.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 252S-253S (April, 1959).

Recent results of the application of electron mirror microscopy for magnetic investigations are reported. It is shown that electron mirror microscopy reveals magnetic domain patterns not only in magnetic materials with a uniaxial direction of easy magnetization but also in materials with several directions of easy magnetization exhibiting basically flux closure domain configurations. On silicon-iron specimens three types of domain manifestation were observed. In two types normal components of the magnetic fields above the entire extension of the domains, weak as they may be, permit the observation. In cases where no such magnetic field components exist, domain walls proper can be observed if magnetic fields are applied. This possibility probably stems from an unsymmetry of the magnetic field above domain walls when a magnetic field is applied. Movements in the domain patterns and domain wall motions can be observed instantaneously because electron mirror microscopy is unhampered by time delays inherent in the Bitter technique. This electronic observation method is also applicable at temperatures at which conventional methods fail. Motion pictures photographed directly from the viewing screen of the electron mirror microscope portray quite adequately the domain patterns set in motion by applied magnetic fields.

539.2 : 538.2

3036 RECENT DEVELOPMENTS IN THE FIELD OF ELONGATED SINGLE-DOMAIN IRON AND IRON-COBALT PERMANENT MAGNETS. R.B.Falk, G.D.Hooper and R.J.Studders.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 132S-133S (April, 1959).

The experimental physical and magnetic properties of elongated single-domain permanent magnets are briefly reviewed with respect to their means of preparation (see also Abstr. 493 of 1956; 2401 of 1958). A successful process is described for making ESD magnets available commercially at a limited initial rate. The material produced is described and contains elongated single-domain particles of iron or iron-cobalt embedded in a metallic matrix to protect them from environmental attack. Maximum magnetic energies of 2.2 MG-Oe for iron and 3.6 MG-Oe for iron-cobalt are available.

539.2 : 538.2

3037 NOVEL LIGHT-WEIGHT MOLDABLE PERMANENT-MAGNET MATERIAL. L.I.Mendelsohn and R.S.Norman.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 142S-143S (April, 1959).

A novel, light-weight, moldable permanent-magnet material is

described. Elongated-single-domain (ESD) particles of iron-cobalt are coated with a thermosetting plastic which serves as matrix. The particles are aligned while the plastic is in a liquid phase. The matrix is then solidified, and the agglomerate ground to a −30 mesh freeflowing powder. Each of the particles of this powder consists of submicroscopic elongated aligned particles. The freeflowing powder can then be directionally pressed in conventional presses to produce magnets of complex shape held to precision dimensions. Energies of 2.0×10^6 G-Oe have been achieved in magnets whose density is 4 g/cm³ and whose temperature coefficient is 0.008%/°C. The material's properties make it well suited to applications where a light-weight, high energy, precision-dimensioned easily fabricated magnet, capable of withstanding adverse environmental conditions is required. An excellent application of this material is the moving-magnet-instrument rotor.

539.2 : 538.2

3038 STABILITY OF MAGNETS COMPOSED OF ELONGATED SINGLE-DOMAIN IRON PARTICLES.
E.J.Yamartino, H.R.Broadley, Jr and R.C.Lever.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 144S-145S (April, 1959).

The magnetic and physical stability of permanent magnets compacted from elongated single-domain iron particles in metallic and organic matrices under various environmental conditions are reported. Changes resulting from two years exposure to 95% relative cycling humidity and 100°C were measured. The influence of powder compacting temperatures, pressures, powder size, and additives are reported. Compacts with lead matrices exposed to 100°C and 95% relative humidity showed gradual magnetic and dimensional changes from insignificant variations after one month to maximums of 0.5% over a two-year period. These results compared favourably with results obtained for Alnico V magnets subjected to identical conditions. Temperatures of 200 to 250°C produced magnetic changes in the order of 1% after one month with physical degradation occurring after two months at 250°C. Magnetic changes of 1% and weight and volume changes in the order of 2% occurred in organic matrix magnets after one month at 100°C. The magnetic changes resulted from a slow oxidation of the iron particles which caused a small decrease of intrinsic saturation induction and an increase in coercive force.

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3039 MEASUREMENT OF WIDTH OF THE BOUNDARY LAYER IN FERROMAGNETICS USING THE MAGNETO-OPTICAL KERR EFFECT. L.V.Kirenskii and V.V.Veter.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 819 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 568-9 (March, 1959).

A method developed for measuring domain-wall thickness in ferromagnetic materials, using the Kerr magneto-optical effect, is described. This was applied to single crystals of 3% silicon–iron, giving a value of 0.8μ. S.A.Ahern

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3040 MAZE PATTERNS ON SILICON IRON. J.Kaczér.
Czech. J. Phys., Vol. 8, No. 6, 747-8 (1958).

It has earlier been suggested that the well known maze pattern domain structure on ferromagnetics is due to internal stresses although there has been no direct experimental evidence of this. In the experiment described a cylinder was machined from a silicon-iron single crystal with a (100) end surface. This face was electrolytically polished and the domain structure was found to have long straight walls typical of stress-free material. The specimen was then subjected to an all-round radial pressure of 10 kg/mm² and a typical zig-zag walled maze pattern was observed. The experiment shows the maze pattern to be due to stresses near the surface. This explains the disappearance of the maze pattern and the appearance of the normal domain structure when some specimens are subjected to tension and also the occurrence of maze patterns on ground and polished surfaces, since the mechanical processes set up elastic stresses of a similar character to those produced by direct radial pressure. F.E.Hoare

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3041 ON THE MAGNETIC STRUCTURE OF CHROMIUM. V.N.Bykov, V.S.Golovkin, N.V.Ageev, V.A.Levdik and S.I.Vinogradov.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 6, 1153-6 (Oct. 21, 1959). In Russian.

Using single crystals of chromium and sensitive detectors, increased intensity and resolution of neutron beams reflected from various crystal planes have been obtained and certain anomalies in the physical properties have been accounted for. A survey was made, using the (100), (110), (111) and (210) planes, at temperatures ranging from −195.8°C up to +200°C. The presence of a second critical point in the (100) reflections at −115°C, in addition to that at +44°C, was revealed. Between the two critical points the (100) reflection was found to consist of three well-defined peaks. The central one was a nuclear reflection, the two outer ones magnetic. The central peak remained of the same intensity as the temperature rose from −115°C to +44°C. Just above −115°C the intensities of the two outer magnetic (100) peaks had their highest values. Then as the temperature rose, the intensities fell away smoothly until at +44°C, they suddenly dropped to negligible values. There was a temperature hysteresis, in that intensities during cooling from +44°C to −115°C were always less than those obtained during heating. The angular separation between the central and each lateral peak was 30' at −100°C, falling to 25' at +20°C. The coefficient of linear expansion also showed anomalous changes at −115°C and +44°C. From −115°C to +44°C is regarded as the range of existence both of magnetic reflections, and also of the antiferromagnetic state. From the splitting of the magnetic (100) reflections it is inferred that the magnetic lattice is not a replica of the crystal lattice, but is deformed into a tetragonally symmetrical lattice when the Cr enters the above range of temperature. The coexistence of two separate lattices can be understood if the existence of elementary domains in the antiferromagnetic is assumed. See also Abstr. 6521 (1958) and 4784 (1959). N.Davy

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3042 NEUTRON DIFFRACTION INVESTIGATIONS OF MAGNETIC PHENOMENA IN CRYSTALLINE COMPOUNDS. M.K.Wilkinson.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 278S-279S (April, 1959).

The summary of a paper which discussed neutron diffraction applications and illustrated recent techniques with investigations on anhydrous iron-group dibromides and dichlorides. (See also Abstr. 6041 of 1958 and 4784 of 1959).

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3043 NEUTRON DIFFRACTION INVESTIGATION OF A POSSIBLE FERRO-ANTIFERROMAGNETIC TRANSITION IN $Mn_{0.2}Cr_{0.8}Sb$. S.J.Pickart and R.Nathans.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 280S-281S (April, 1959).

Neutron powder patterns of the hexagonal compound $Mn_{0.2}Cr_{0.8}Sb$, in which magnetization measurements indicate an antiferromagnetic–ferromagnetic phase change, show that within the antiferromagnetic region the spin structure is similar to that of CrSb. Below the ferromagnetic Curie point weak superstructure lines appear, with the relative intensities of the remainder of the neutron pattern changing only slightly. Additional measurements on the compound MnSb indicate that the spin structure is ferromagnetic with the moments directed along the hexagonal c axis. The results are discussed in relation to the types of exchange interactions present in these materials.

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3044 ANNEALING STUDY IN A PILE IRRADIATED CRYSTAL. R.C.Hall, W.S.Byrnes and R.G.Crawford.
J. appl. Phys., Vol. 30, No. 11, 1846-7 (Nov., 1959).

The magnitude of the magnetic anisotropy constant K_1 of a water-quenched and neutron irradiated 15 wt. % AlFe alloy increases more rapidly on annealing than for a similar non-irradiated alloy subjected to the same anneals. This is attributed to more rapid ordering in the Fe_3Al phase due to enhanced diffusion after neutron bombardment. A.J.Manuel

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3045 RELAXATIONAL BEHAVIOR OF FINE MAGNETIC PARTICLES. W.F.Brown, Jr.
J. appl. Phys., Supplement to: Vol.30, No.4, 130S-132S (April, 1959).

Weil and others have used the temperature variation of remanence and a formula of Néel's to determine volume-distribution curves for a powder of single-domain particles. The basic principle is that the time constant for spontaneous reversal of the magnetization, through thermal agitation, is effectively infinite for particle volume $v > v_c$ and zero for $v < v_c$, where v_c varies with absolute

temperature T. Néel's derivation is open to criticism, in that the gyromagnetic properties of the particles are taken into account only up to a certain point in the argument and are thereafter ignored. A new formula has been derived by adaptation of a method of Kramers to angular coordinates and to a gyroscopic equation of motion. Like Néel's theory, this gives for the mean rate of transition between orientations a formula of the form $\nu = c \exp(-W/kT)$; W is the same in both theories, but in the new theory

$$c = (\gamma'/2)(vJ_s H_c^3/2\pi kT)^{1/2},$$

where $\gamma' = (2\eta J_s)[(\eta J_s)^2 + 1/\gamma^2]^{-1}$,

H_c = critical field for static reversal, J_s = spontaneous magnetization, γ = (magnetic moment)/(angular momentum), η = coefficient in the damping torque $-\eta M \times (dM/dt)$ in Gilbert's equation of motion. The new values of v/T versus time constant do not differ seriously from Néel's.

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3046 MAGNETISM OF SUBMICROSCOPICAL IRON PARTICLES. K.J.Kronenberg.

J. appl. Phys., Supplement to: Vol.30, No.4, 138S-139S (April, 1959).

The magnetic fields around submicroscopical iron particles were tested with iron oxide colloid in an electron microscope. The colloid particles usually spread evenly by diffusion. Magnetic fields of several hundred oersteds are required to concentrate the colloid particles visibly at certain spots. Colloid was found around iron particles concentrated to various degrees. The colloid was attracted less by smaller particles. The smallest particles did not attract any colloid. The particles were measured and grouped into the three following categories: (a) Particles with strong, all around colloid attraction, indicating many domains. Stem volume of the dendritic particles much bigger than 10^9 A^3. (b) Particles with colloid attractions at spots, indicating one or a few domains. (c) Particles without colloid attraction, indicating no well-developed domains. Stem volume much less than 10^9 A^3.

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3047 PROPERTIES OF MULTIDOMAIN PARTICLES. H.Amar.

J. appl. Phys., Supplement to: Vol.30, No.4, 139S-141S (April, 1959).

The theoretical interpretation of the size-dependence of the coercive force $H_c(x)$ of fine ferromagnetic powders and thin films is still an unsolved problem. Kittel and Néel's treatments are discussed, and some recent work of the author along similar lines is presented. An alternative heuristic approach is suggested, leading to an expression $H_c = \text{const} \times (x^2 + b^2)^{-1}$ and is compared to some of the recent experimental data.

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3048 SHAPE DISTRIBUTION OF MAGNETITE POWDERS. C.E.Johnson, Jr and W.F.Brown, Jr.

J. appl. Phys., Supplement to: Vol.30, No.4, 136S-137S (April, 1959).

The shape distribution curves of single-domain magnetite powders calculated from magnetic data do not agree with those observed in the electron microscope. The Stoner-Wohlfarth theory, from which the magnetic unaveraging process was derived, ignores magnetocrystalline anisotropy. This may be one of the contributory causes to the lack of agreement. To establish this, the shape curves were measured magnetically on both acicular and equant magnetite powders at various temperatures. The magnetocrystalline anisotropy of magnetite is temperature dependent, changing from about -1×10^5 erg/cm^3 at room temperature to $+1 \times 10^5$ erg/cm^3 at -165°C. The magnetically calculated shape curves show some change with temperature; this indicates a contribution from the magnetocrystalline anisotropy.

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3049 INTERNAL STRUCTURE OF CROSS-TIE WALLS IN THIN PERMALLOY FILMS THROUGH HIGH-RESOLUTION BITTER TECHNIQUES. R.M.Moon.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 82S-83S (April, 1959).

The use of a water immersion objective with the optical microscope for Bitter pattern studies has resulted in a significant improvement in resolution. A discussion of technique in using such an objective is presented. Applied to the study of cross-tie domain walls in thin Permalloy films, this technique has revealed details of internal wall structure. In the proposed model for such walls the magnetization within the wall is thought to be predominantly in the plane of the film, with periodic transition regions in which the magnetization is normal to the film. This configuration reduces the large magnetostatic energy which would be associated with a conventional 180° wall. Areas of low particle density are observed at the intersection of the main wall and cross-ties and in the main wall midway between cross-ties. From conventional ideas of colloid-pattern formation, these areas might be expected to have a high particle density because they are the transition regions in which the magnetization is normal to the film. The apparent conflict is resolved by assuming that these regions are large compared to the colloid particle size that so that the fringing field at the edge of the region governs the particle distribution. In support of the model, evidence is presented of the reported shift of colloid particles when an external field is applied normal to the film.

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3050 OBSERVATIONS MADE ON DOMAIN WALLS IN THIN FILMS. H.W.Fuller and H.Rubinstein.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 84S-85S (April, 1959).

Domain walls in thin films of permalloy were previously found, by Huber et al., to frequently exhibit periodically spaced "cross-ties". These wall structures have been studied in some detail in a variety of alloys and the model advanced by Huber et al. largely substantiated. Of some interest is the great sensitivity of the position of normal spin orientation between cross-ties to externally applied fields. A nonmagnetic overcoating on a thin film, and dark-field illumination with restricted-azimuth are methods which are valuable in such observations using the Bitter technique. Other characteristic wall configurations peculiar to thin ferromagnetic films have been observed and models have been devised for the magnetization distributions. Powder patterns have been observed on an iron film at intermediate stages of the slow switching of the film. The powder is seen to collect along lines perpendicular to the applied field prior to the formation of domains. A model based on magnetization buckling is suggested that establishes a connection between the lines that form before partial switching of the film, and the cross-ties that appear on domain walls after partial switching. Long Néel-wall segments have been observed on thin films by the Bitter technique, and by the use of fields in the plane of the film and at right angles to the wall. It has been found possible to reversibly change the direction of the magnetization in the Néel wall with such fields without introducing wall motion.

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3051 PARTIAL SWITCHING OF THIN PERMALLOY FILMS. F.B.Hagedorn.

J. appl.Phys., Supplement to: Vol. 30, No. 4, 254S-255S (April, 1959).

The switching processes in thin Permalloy films have been investigated by means of partial switching. The procedure was to interrupt the switching process before completion and then to complete the reversal with a second switching pulse. Comparison of partial switching with complete switching in thin films confirms the existence of nonuniform rotation, a reversal mode different from either wall motion or uniform rotation. The domain structure of the partially switched states has also been determined. Several characteristics of nonuniform rotation have been inferred from the domain structure and from the partial switching wave forms. However, it has not been found possible to correlate these characteristics with a detailed model of the nonuniform rotational process.

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3052 STRUCTURAL AND MAGNETIC PROPERTIES OF PERMALLOY FILMS. J.C.Lloyd and R.S.Smith.

J. appl. Phys., Supplement to : Vol. 30, No. 4, 274S-275S (April, 1959).

The wall motion coercive force H_c and the rotational coercive force H_r of thin electroplated nickel-iron films are studied as a function of film roughness. Three types of roughness are considered: the first, periodic with a wavelength large compared to a domain wall width and an amplitude small compared with the film thickness; the second, of the order of size of a domain wall; and the third, a substrate roughness that is large compared to the film thickness. H_c was found to be related to film thickness according to $H_c = CsD^{+n}$. This observation was predicted by Néel, except that his assumption of a form of roughness only of the first kind led to a single value for n of $-\frac{4}{7}$. Electron micrographs showed that roughness of the second kind increased with film thickness, indicating that n depends on this factor. Roughness of the third kind, as introduced by unidirectional polishing, results in an increase of Cs, while n and H_r are not affected. This third type of roughness was observed to orient the easy magnetic axis parallel to the polishing grooves.

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3053 SLOW DOMAIN WALL MOTION IN HOMOGENEOUS VACUUM-DEPOSITED IRON-NICKEL FILMS.

R.W.Olmen and E.N.Mitchell.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 258S-259S (April, 1959).

An experimental study has been made of slow-speed domain wall velocity as a function of switching field and temperature for a "homogeneous" vacuum-deposited magnetic film using the Kerr magneto-optic technique for visual and photographic velocity measurements. The deposited film was in the form of a circle, one centimeter in diameter and about 1500 A thick with a composition of about 78% nickel and 22% iron. In the film studied, domain walls continue in motion until the film is saturated without any increase in the applied magnetic field over that necessary to just nucleate the domain. The general expression obtained for the domain wall velocity as a function of applied field H and temperature t for a contained wall is $V = V_o(t) \exp 8.8 (H - H_o)$, where H is in oersteds and V is in cm/sec. It was also determined that the domain wall velocity increases with increasing temperature at a fixed value of the applied magnetic field. The plotted data is nonlinear but in general the velocity increases with temperature at a rate greater than the first power of the temperature but less than the square of the temperature. Observations were made over a range of wall velocities from 3.4×10^{-4} cm/sec to 7.6×10^{-3} cm/sec.

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3054 STRESS ANISOTROPY IN Ni–Fe THIN FILMS. J.D.Blades.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 260S-261S (April, 1959).

The effective domain anisotropy energy of Baltzer has been extended to a simple, randomly oriented polycrystalline, single domain thin film under the influence of an isotropic planar and linear stress system. Energy equilibrium conditions lead to the definition of an average effective rotational anisotropy field, H_s. Utilization of the monocrystal data of Hegg, and Bozorth, and Walker for Ni–Fe with the linear stress determination of MacDonald permits a qualitative prediction of H_s. Measurements of H_c, and H_k on evaporated Ni–Fe thin films for three substrate temperatures at various compositions indicate the existence of a stress anisotropy below possibly a recrystallization temperature, which varies with composition.

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3055 ANISOTROPY AND COERCIVITY IN THIN FILMS. C.J.Kriessman, H.S.Belson and F.H.Edelman.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 262S-263S (April, 1959).

An arbitrary classification of thin films into three types may be made on the basis of the relative values of the anisotropy field, H_K, and the intrinsic coercive force of the material, H_I. These three types are (A) $H_K > H_I = 0$, (B) $H_K = 0$; $H_I \neq 0$, and (C) $H_I > H_K \neq 0$. In case A, the magnetization will seek the easy direction in the absence of an applied field and the film will have a rectangular hysteresis loop in the easy direction only. Certain films have isotropic magnetic properties in all directions. The magnetization in such films will remain in any direction to which it is moved by a field larger than the coercive force. These films are therefore classified as $H_K = 0$ films. The third type of film has rectangular hysteresis loops in all directions but different apparent coercive forces, H_F, in different directions.

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3056 ANISOTROPY IN PERMALLOY FILMS. D.O.Smith.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 264S-265S (April, 1959).

Evaporated films of Permalloy are found to be uniaxially anisotropic under all the conditions of preparation studies so far, including deposition in d.c., zero, and rotating-circular magnetic fields. Three principal effects have been identified as contributing to this anisotropy, namely; (1) the formation of directed Fe pairs in the Ni matrix, (2) an effect due to the angle-of-incidence between the substrate and the depositing beam, and (3) anisotropic stress in combination with the isotropic magnetostriction. The evidence for directed pairs comes from the compositional dependence of the anisotropy; the angle-of-incidence effect is demonstrated by depositing onto tilted substrates; anisotropic stress effects are shown by detaching the film from the substrate. The simultaneous presence and interaction of the above effects is thought to be the reason for the variability in the anisotropy which is encountered in Permalloy films.

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3057 ANISOTROPY FIELD MEASUREMENTS ON Ni–Fe THIN FILMS. R.G.Alexander.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 266S-267S (April, 1959).

Rotation anisotropy fields have been determined in vacuum deposited Permalloy films using pulsed external fields. The signal producing field is applied at right angles to the direction of easy magnetization, while the effective reset field is applied at a variable acute angle to the direction of easy magnetization. A special type of permeability curve is constructed using the integrated output signal. Values of the effective rotation anisotropy and the distribution of the anisotropy are determined from this curve, and are found to be related to the squareness at 90° to the easy direction.

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3058 PROPERTIES OF PERMALLOY FILMS HAVING A MAGNETOELASTIC EASY AXIS NORMAL TO THE FILM. E.E.Huber, Jr and D.O.Smith.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 267S-269S (April, 1959).

Internal isotropic strain in Permalloy films having a negative magnetoelastic constant creates a magneto-elastic easy axis normal to the film. Below a critical thickness t_c such films are single domain in the film plane and have a square B-H loop; above this thickness new configurations are established, characterized by a B-H loop of special form and having relaxation properties. Above t_c the Bitter pattern is "mottled" and continues so even in the presence of a 10 000 Oe field. A domain structure is proposed in qualitative agreement with experiment; mottling is interpreted in terms of centres of microstrain.

539.2 : 538.2

3059 ROTATIONAL HYSTERESIS IN THIN FILMS. J.R.Mayfield.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 256S-257S (April, 1959).

Rotational losses in films of nickel-iron have been studied over a wide range of frequencies and applied fields by measuring the torque exerted on the films by a rotating magnetic field. Rotational frequencies from 10 c/s to 1 Mc/s and field intensities from zero to 100 Oe were used with films ranging in nickel content from 70 to 90% and in thickness from 400 to 12 000 A. For applied fields less than 2K/M, the observed losses agree well with the theory of rotational hysteresis in materials with uniaxial anisotropy. When combined with standard torque or hysteresis loop data, these losses yield information regarding the uniformity of the effective anisotropy within the sample. In fields considerably greater than 2K/M the loss per cycle for any given sample is found to be independent of the rotational frequency. According to the analysis of Gilbert and Kelly, in which the high-field losses are proportional to the intrinsic damping parameter, these experimental results imply an inverse frequency dependence of the damping parameter. However, correlations between the high-field and the low-field losses, as well as the results of certain auxiliary experiments indicate that the high-field losses are of essentially the same origin as the low-field losses and are not a measure of the intrinsic rotational damping.

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3060 INFLUENCE OF SUBSTRATE PROCESSING ON THE MAGNETIC PROPERTIES AND REPRODUCIBILITY OF EVAPORATED NICKEL-IRON FILMS.

K.H.Behrndt and F.S.Maddocks.

J. appl. Phys., Supplement to : Vol. 30, No. 4, 276S-277S (April, 1959).

The properties of evaporated nickel-iron films, deposited on substrates cleaned with detergent only, were observed to vary widely from one evaporation run to another and even within a run. This erratic variation is believed to be due partially to inhomogeneities in the surface structure of the substrates. Several other substrate cleaning techniques were evaluated for their effectiveness in reducing this variation in film properties. As a result, both wall motion and rotational threshold have been lowered, and the average percentage variations of the magnetic properties have been considerably reduced. Because of the resulting improvement in film

reproducibility, it has been possible to verify the predicted dependence of domain wall coercive force on film thickness, even for films which had been deposited in separate evaporations.

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3061 MEASUREMENT OF THE MAGNETIC FIELD IN A THIN FILM. S.Yamaguchi.

J. appl. Phys., Vol. 30, No. 10, 1619-20 (Oct., 1959).

Electron diffraction measurements were used to obtain the saturation induction of a 5μ electrodeposited nickel film.

E.P.Wohlfarth

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3062 SATURATION MAGNETIZATION OF NICKEL FILMS OF THICKNESS LESS THAN 100 A. C.A.Neugebauer.

Phys. Rev., Vol. 116, No. 6, 1441-6 (Dec. 15, 1959).

Nickel films varying in thickness from 200 to 3 A were prepared by evaporation on glass substrates in a vacuum sufficiently high to prevent gas adsorption on the film during preparation and measurement. Their magnetization was measured as a function of field up to 10 000 Oe using a vacuum torsion magnetometer. The saturation magnetization of these films was determined as a function of their thickness at 300° K and 77° K. No decrease in saturation magnetization from that of bulk nickel was observed for films of thickness down to 20 A, at room temperature. The Curie temperature of a 27 A film was found to coincide with that of bulk nickel. The magnetic behaviour of films in the thickness range below 20 A suggests superparamagnetism rather than a decrease in the saturation magnetization. Measurements of the magnetostrictive anisotropy constant indicate that the films as originally prepared are in a state of high tensile strain, which can be relieved by annealing. The thin film nature of some specimens was ascertained by examination in the electron microscope.

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3063 A STUDY OF THE INFLUENCE OF DISLOCATIONS ON SOME OF THE MAGNETIC PROPERTIES OF PERMALLOY ALLOYS. Z.Málek.

Czech. J. Phys., Vol. 9, No. 5, 613-26 (1959).

The influence of dislocations (produced during plastic pulling) was studied experimentally, with special reference to the coercive force of f.c.c. Fe–Ni alloys. Vicena's theory (Abstr. 7511 of 1956) is rendered more accurate, and the dependences of the coercive force on the plastic lengthening of the samples are derived. The results are compared with the measured dependence. The observed anomalies are explained.

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3064 EFFECT OF COMPOSITION AND PROCESSING ON THE ACTIVITY OF SOME MAGNETOSTRICTIVE MATERIALS. C.M.Davis, Jr and S.F.Ferebee.

J. appl. Phys., Supplement to: Vol.30, No.4, 113S-115S (April, 1959).

The dynamic magnetostrictive properties of a number of magnetic materials were determined as a function of composition and processing. The materials investigated include nickel, 2V-Permendur, a cobalt-nickel alloy, several Ni-Fe and Al-Fe alloys, and a group of ferrites represented by the formula $Ni_{1-x-y}Co_xFe_{2+y}O_4$ with $0.00 \leq x \leq 0.04$ and $0.00 \leq y < 0.08$. The parameters measured were: electromechanical coupling coefficient k, reversible permeability μ_r, dynamic magnetostrictive constant λ, Young's modulus E, and stress sensitivity $\lambda\mu_r$. The stress sensitivity of both the Al-Fe alloys and the cobalt-substituted nickel ferrous-ferrites is sensitive to cooling rate. Ordered Al-Fe samples containing approximately 12.0% aluminium were more stress sensitive by a factor of six than were disordered samples of the same compositions. Disordering was accomplished by quenching from above the ordering temperature (approximately 600°C). When 6% of the nickel in cobalt-substituted nickel ferrite was replaced by divalent iron, the value of $\lambda\mu_r$ increased by approximately 40% for quenched samples but remained relatively constant for slow-cooled samples. The largest values of $\lambda\mu_r$ observed in the Ni-Fe alloys (in excess of 10^6 dyne/cm^2) occur in the range of 40 to 52.5% nickel. Various processing techniques were employed on the Ni-Fe alloys in this range: slow cooling quenching, magnetic annealing, and variation in annealing temperature between 900 and 1220°C. Such variations in processing failed to produce more than a 10% change in the value of $\lambda\mu_r$.

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3065 MAGNETIC CONTRIBUTIONS TO THE ELASTIC CONSTANTS OF NICKEL AND AN Fe-30% Ni ALLOY AT HIGH MAGNETIC FIELDS. G.A.Alers, J.R.Neighbours and H.Sato.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 231S-232S (April, 1959).

The possibility that the fundamental interatomic magnetic interaction makes an observable contribution to the elastic constants of a ferromagnetic metal has been investigated experimentally in nickel and an Fe-30% Ni alloy. The effects of a noncentral interaction were found to be too small to be observed or were masked by effects arising from magnetization direction changes induced by the measurement process. The central force part of the interaction which should produce changes in the elastic constants upon passing through the Curie temperature was clearly observed in both nickel and the Fe-30% Ni alloy. The interpretation of these results in terms of the magnetic exchange energy is straightforward for nickel but the large volume magnetostriction in the Fe–Ni alloy makes the analysis of the data difficult.

539.2 : 538.2

3066 EFFECT OF ORBITAL DEGENERACY ON MAGNETOELASTIC ENERGY. J.C.Slonczewski.

J. appl. Phys., Supplement to: Vol.30, No.4, 310S-311S (April, 1959).

Because of the configurational instability of an orbitally degenerate system, ferrimagnetic crystals containing orbitally degenerate cations should exhibit large magnetostriction. The effect of orbital degeneracy of Co^{2+} on magnetostriction in cobalt-iron ferrite is calculated by means of perturbation theory. A value of $1.4 \times 10^3 cm^{-1}$ for trigonal crystal field splitting of Co^{2+} is inferred by comparing calculated results with experimental data.

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3067 MAGNETOSTRICTION CONSTANTS IN IRON AND SILICON-STEEL. E.Tatsumoto, T.Okamoto, A.Nishimura and A.Fukai.

J. Sci. Hiroshima Univ. A, Vol. 22, No. 2, 123-35 (Sept., 1958).

The magnetostriction constant λ_{100} in iron and in 1.1 and 3.8% silicon steels has been obtained at room temperature with (100)–[100] single crystal strips having favourable domain structures, produced by applying a certain constant direct current through the specimens. The other magnetostriction constant λ_{111} has also been observed with the $(\bar{1}10)$–[111] single crystal strips. At room temperature, dependence of the magnetostriction constants on the silicon content of the iron was ascertained to be almost the same as that presumed by Carr and Smoluchowski: that is λ_{100} has a maximum value around 2% Si by weight, and λ_{111} decreases in absolute value with increase of the Si content. In connection with the observations of magnetostriction, the effect of glue used to cement the strain gauges on the domain structures has been experimentally discovered, and qualitatively discussed. Magnetostriction phenomena in the magnetization process, moreover, have been observed and the behaviour somewhat phenomenologically discussed

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3068 ANALYSIS OF MAGNETOSTRICTION. E.Tatsumoto, A.Fukai and T.Okamoto.

J. Sci. Hiroshima Univ. A, Vol. 22, No. 2, 137-45 (Sept., 1958).

Bulk linear magnetostriction of a ferromagnetic crystal is phenomenologically treated with the result that the strain in the measured direction is only due to the spontaneous magnetostriction of each domain in the crystal. It must be, however, the resultant contribution not only of the spontaneous magnetostriction, but also of the induced strain in order to maintain the constituent domains spontaneously strained in elastic equilibrium throughout the whole specimen. This idea was investigated by experiments using (001)–[100] single crystal strips of 1.1% Si–Fe which have exceedingly simple domain configuration at the demagnetization state.

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3069 MEASUREMENT OF FERROMAGNETIC RELAXATION BY A MODULATION TECHNIQUE. J.I.Masters and R.W.Roberts, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 179S-180S (April, 1959).

A modulation method is introduced as a novel means of studying directly the relaxation process in the case of ferrimagnetic rare earth garnets and ferrites. The method directly measured the relaxation of the spin system of the material which is identified with the transverse relaxation time by means of the standard equations of motion. A low-power fixed frequency X-band microwave field is amplitude modulated at an r.f. rate up to 50 Mc/s while maintaining

the sample in ferromagnetic resonance. The resulting precession of the magnetic moment will then contain an r.f. component which is a function of both the transverse relaxation time and the frequency of the r.f. modulation. The precession is observed by a single turn pickup loop in which the induced microwave voltage is proportional only to the rotating component of magnetization. The r.f. signal resulting from demodulation of this voltage then characterizes the response of the precession to the modulation frequency of the driving microwave field. The falloff in this response with increasing modulation frequency is shown to be related to the transverse relaxation time by means of the equations of motion. The predicted form of this falloff is a function proportional to the factor $(1 + \beta^2\tau^2)^{-1/2}$ from which the relaxation time τ is obtained. Certain conclusions may be drawn from the excellent agreement of the experimental data with theory.

539.2 : 538.2

3070 EFFECT OF CHEMISORBED HYDROGEN ON THE MAGNETIZATION OF NICKEL AT LOW TEMPERATURES. R.E.Dietz and P.W.Selwood.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 101S-102S (April, 1959).

The saturation magnetization of nickel particles in the range 10-100 A has been determined by extrapolating from magnetizations measured at 4.2°K in fields up to 10^4 Oe. Measurements have been made prior to, and after, the admission of hydrogen to the nickel at room temperature. The nickel is supported on silca in the manner familiar in heterogeneous catalysis. The number of d electrons paired per hydrogen atom adsorbed has been calculated from the fractional change in saturation magnetization assuming the magnetic moment per atom of nickel to be 0.606 Bohr magneton. The ratio of d electrons pairs to hydrogen atoms adsorbed has been shown to be less than one. On sintered samples in which the average nickel particle diameter is 40-80 A the ratio is about 0.7. On smaller nickel particles the ratio may be less. This ratio does not appear to be sensitive to surface coverage. The fact that the ratio of d electrons paired to hydrogen atoms adsorbed is less than one is considered evidence for a localization of the electronic interaction between adsorbent and adsorbate.

539.2 : 538.2

3071 IN-PILE MEASUREMENTS OF RADIATION EFFECTS IN MAGNETIC MATERIALS. R.E.Alley, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 284S-285S (April, 1959).

Experiments have been performed at Brookhaven National Laboratory to determine the effects of nuclear reactor radiation upon the characteristics of ferrites and metallic magnetic materials. Photographs of 60 cycle hysteresis loops and bridge measurements of 1000 cycle inductance were made before irradiation, periodically during irradiation, and after reactor shutdown. The samples were irradiated for 12 days, resulting in an integrated fast flux of 1.6×10^{17} neutrons/cm^2. No permanent effect was observed in any ferrite. In-pile changes in ferrite properties are identified with changes due to temperature variations resulting from gamma ray absorption. Permanent damage was observed in all metallic samples tested. Supermendur and Deltamax were least affected, showing increases of the order of 50% in coercive force and small decreases in initial permeability. Various samples of 4-79 Mo-Permalloy were affected differently, but all showed change in shape of hysteresis loop, several hundred percent increase in coercive force, and about 80% decrease in initial permeability. Supermalloy was most damaged by radiation, showing marked effects after 24 hr, and progressively greater effects throughout the exposure period.

539.2 : 538.2

3072 PROPOSED MEANS FOR REALIZING HIGH POWER STABILITY IN MAGNETIC OXIDES.

L.G.Van Uitert, R.C.LeCraw, E.G.Spencer and R.L.Martin.

J. appl. Phys., Vol.30, No.10, 1623-4 (Oct., 1959).

The factors governing the stability of magnetic oxides to r.f. power level are discussed. It is shown the stability should be improved by increasing the spin-wave line width, which may be accomplished by adjusting the composition or the structure of the oxide.

S.A.Ahern

539.2 : 538.2

3073 DISTRIBUTION OF CATIONS IN SPINELS. A.Miller.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 24S-25S (April, 1959).

The concept of octahedral site preference energy in spinels has been extended to include Madelung and short-ranged as well as crystal field terms. A set of site preference energies is formulated which can be used to predict the ionic distribution of spinels involving the nontransition as well as the transition ions. The agreement between predicted and experimentally determined ionic distributions is surprisingly good, and a number of heretofore puzzling distributions are explained.

539.2 : 538.2

3074 MAGNETIC PROPERTIES OF SUBSTITUTED MANGANESE-TIN SPINELS.

M.A.Gilleo and D.W.Mitchell.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 20S-21S (April, 1959).

In a $Me_2^{2+}Sn^{4+}O_4$ spinel, Sn^{4+} is known to occupy octahedral sites. Therefore manganese-tin spinel, $(Mn)[MnSn]O_4$, would be antiferromagnetic because of the strong interaction between octahedral and tetrahedral ions characteristic of magnetic spinels. When the initial equality of the sublattice magnetizations of Mn^{2+} ions in octahedral and tetrahedral sites is upset by substitution of nonmagnetic, divalent ions, Mg^{2+} and Zn^{2+}, for Mn^{2+}, spontaneous magnetization appears. The Néel temperature is decreased by these substitutions largely as a consequence of the smaller number of interactions between the reduced number of Mn^{2+} ions in the two different sites. The sequence, Mg^{2+}, Zn^{2+}, Mn^{2+}, of increasing size sizes corresponds to that of increasing lattice constants, 8.60, 8.67, 8.88 A, of the respective tin spinels. Substitution of Ge^{4+} for Sn^{4+} takes place principally in tetrahedral sites because of the very small size of Ge^{4+}. Similarly, spontaneous magnetization appears with oxidation of Mn_2SnO_4. The resultant oxidized manganese ions (presumably Mn^{3+}) are of the same average valence, though of smaller size, than the octahedral ions and, therefore, also appear in octahedral sites. Because Sn^{4+} is rejected to maintain valence balance, the octahedral sublattice magnetization is increased by oxidation.

539.2 : 538.2

3075 MAGNETIC PROPERTIES AND GRAIN STRUCTURE OF Mn-Zn FERRITES. W.Heister.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 22S-24S (April, 1959).

The relations between sintering temperature, grain size and magnetic properties of a manganese zinc ferrite of composition $MnO:ZnO:Fe_2O_3 = 28:19:53$ are reported. With proper preparation, very low loss materials can be obtained.

539.2 : 538.2

3076 REMAGNETIZATION EXPERIMENTS IN $Mn_{1+x}Fe_{2-x}O_4$. T.J.Matcovich and C.J.Kriessman.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 26S-27S (April, 1959).

The remagnetization time τ has been measured as a function of external field H for a series of manganese ferrites, $Mn_{1+x}Fe_{2-x}O_4$. The physical properties of these compounds which enter into the domain wall model of Menyuk and Goodenough and the rotational model of Gyorgy have also been measured. It is found that α, the loss constant, is critical to the correlation of data with theory, and that neither theory can be unequivocally proved until more insight into the remagnetization process loss mechanism is acquired.

539.2 : 538.2

3077 ON THE RECTANGULARITY OF THE HYSTERESIS LOOP OF MANGANESE FERRITE. A.Bragiński.

Czech. J. Phys., Vol. 9, No. 6, 755-6 (1959).

539.2 : 538.2

3078 THE PERMINVAR EFFECT AND MAGNETIC AFTER-EFFECT IN MAGNESIUM MANGANESE FERRITE.

J.Brož, S.Krupička and B.Zítka.

Czech. J. Phys., Vol. 9, No. 3, 314-23 (1959).

An unstable perminvar effect was found at −195°C, and its connection with the magnetic after-effect was investigated. An analysis, carried out on the basis of Néel's theory showed that both effects are a result of the same diffusion process. The experimental results also show that 180° Bloch walls are displaced when the sample is magnetized.

539.2 : 538.2

3079 ON THE ORIGIN OF LOW MOMENTS IN CHROMIUM-CONTAINING SPINELS. P.K.Baltzer and P.J.Wojtowicz.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 27S-29S (April, 1959).

The common interpretation of the low magnetic moments of chromium-containing spinels relies on the existence of the Yafet and Kittel ordering scheme. The experimental evidence for angular

ordering schemes on the B lattice of spinels is, however, inconclusive and contradictory. Prince, for instance, has obtained neutron diffraction data on $CuCr_2O_4$ which is consistent with, but does not uniquely determine, the Yafet–Kittel scheme. Pickart, on the other hand, has found no evidence of the angular scheme in data on $(MnFe_2O_4)_{1-x} + (MnCr_2O_4)_x$ and $(NiFe_2O_4)_{1-x} + (NiCr_2O_4)_x$, although he did establish that the moment of the B lattice was lower than expected on a simple Neel picture. This report presents an approach to the problem which appears to lead to a reasonable, adequate, and consistent treatment of the moment data. It is proposed that the origin of the low moments in the chromites is the spin-quenching effect imposed on the Cr^{3+} ions by the appropriate Jahn–Teller distortions of their neighbours, and it is emphasized that a macroscopically distorted phase is not required for this effect. It is only necessary that a distribution of distorting neighbours be present, sufficient in number to alter the symmetry about (and hence spin quench) at least a fraction of the chromium ions. With the aid of these hypotheses it has proved possible to explain the moment data for many chromites in a consistent way. Of particular interest are the recently studied systems, $(CuFe_2O_4)_{1-x} + (CuCr_2O_4)_x$ and $(NiFe_2O_4)_{1-x} + (NiCr_2O_4)_x$.

539.2 : 538.2

3080 MEASUREMENTS OF ROTATIONAL MAGNETIC LOSSES IN FERRITES AT VERY LOW FREQUENCIES. H.M.Parker, B.W.Bullock and W.H.Dancy, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 32S-33S (April, 1959).

Apparatus has been developed and successfully operated in which rotational magnetic losses in ferrites are measured at frequencies of the order of 0.1 c/s in fields up to about 5000 G and over a reasonably wide temperature range. It consists of a quartz fibre torsion pendulum (the fibre perpendicular to the field) operating in a vacuum and in a reasonably constant temperature enclosure. The principle involved is that of observing the decay of free oscillations of the systems, and determining the torques due to the damped oscillatory system. The samples are ground into spheres to accuracies of the order of 0.1% which can be improved if desired. In the absence of magnetic anisotropy of the sample, the method can, in principle, distinguish between Coulomb or constant torque losses (customarily assumed for rotational hysteresis loss torque) and loss torques proportional to the angular velocity (viscous). However, for all samples so far measured the anisotropy has been sufficiently large to prevent the disentangling of the Coulomb and viscous losses. (Qualitative indications of the anisotropy are obtained from the measurements and it is interesting that the losses and anisotropy seem to be proportional). The procedure has been to assume the losses are of the constant torque type and determine them by making the best engineering fit with the decay curves.

539.2 : 538.2

3081 SOME CRYSTALLOGRAPHIC AND MAGNETIC PROPERTIES OF SQUARE-LOOP MATERIALS IN FERRITE SYSTEMS CONTAINING COPPER. A.P.Greifer and W.J.Croft.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 34S-36S (April, 1959).

Rectangular hysteresis loops have been found in ferrite systems containing copper during an investigation based on the proposal by Baltzer that a zero or near-zero value of the effective magnetocrystalline domain anisotropy is a necessary condition for loop squareness. Data on hysteresis loop squareness of polycrystalline bodies as a function of composition, firing conditions and magnetostrictive effects are presented for the system: copper ferrite-magnesium ferrite. This system is characterized in general by large grains and long switching times. Abrupt flux changes occur in the hysteresis loop at low temperatures. Simultaneously, a decrease in the coercive force with decreasing temperature and squareness values approaching unity are observed. No crystallographic transitions were detected at low temperatures. Magnetostrictive measurements do not unequivocally show whether anisotropy goes through zero at compositional region of maximum squareness. The saturation magnetistriction and probably the λ_{111} go through a minimum in this region.

539.2 : 538.2

3082 MAGNETIC PROPERTIES OF NICKEL-IRON FERRITE. N.Menyuk and K.Dwight.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 36S-37S (April, 1959).

The magnetic anisotropy of a single crystal of nickel–iron ferrite with composition $Fe^{3+}_{1.00}[Ni^{2+}_{0.70}Fe^{2+}_{0.30}Fe^{3+}_{0.00}]O_4$ is given between 450 and 4.2°K. At high temperatures the anisotropy energy has cubic symmetry, and the absolute value of the first-order anisotropy constant is a maximum near 200°K. Below 200°K, $|K_1|$ decreases until 10°K, at which temperature there is an abrupt transition in the anisotropy characteristics. Below 10°K the anisotropy energy contains a uniaxial term of the form $\Sigma_i \alpha_i^2 \beta_i^2$ where α_i and β_i are the direction cosines of the magnetization at the measuring temperature and at the annealing temperature (10°K), respectively. This low-temperature behaviour has been explained on the basis of existent theory of magnetic annealing. The model used to explain the uniaxial anisotropy term given above is shown to be consistent with the non-cubic anisotropy energy obtained upon cooling the sample through 10°K in the absence of an external field. The model is also shown to lead directly to a relaxation effect which contributes a term of the form $K'(\alpha_1^2\alpha_2^2 + \alpha_2^2\alpha_3^2 + \alpha_3^2\alpha_1^2)$ to the anisotropy energy above 10°K and explains the observed maximum in $|K_1|$.

539.2 : 538.2

3083 INITIAL PERMEABILITY PROCESSES IN NICKEL-COBALT FERRITES OF VARIOUS DENSITIES. J.E.Pippin and G.H.Thiess.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 80S-81S (April, 1959).

Initial permeability has been measured at a frequency of 10 Mc/s on ferrites of composition $Ni_{1-\alpha}Co_\alpha Mn_{0.08}Fe_{1.92}O_{4\pm\delta}$ with varying densities. Here α = 0, 0.005, 0.01, 0.015, 0.02, 0.025, 0.03, 0.04, and 0.06, and density is varied for each composition between 3.8 g/cm³ and 5.1 g/cm³. The data are presented in a family of curves of permeability, μ', against density with α as a parameter, and μ' against α with density as a parameter. For α = 0, the extremely rapid increase of μ' at high density is indicative of an increase in wall motion, the increase being much too sharp to explain by a rotational model. For $\alpha \geq 0.04$, this rapid increase is not seen, suggesting that the walls are almost completely pinned at these cobalt contents. For high densities, the curve of μ' against α shows a sharp decrease with the first cobalt addition, then rises to a maximum near α = 0.03, and decreases for further cobalt additions. But ferromagnetic resonance line width measurements show that the crystalline anisotropy is decreased by the first cobalt addition, reaches a minimum near α = 0.03, and subsequently increases again. It is concluded that rotational contributions to μ' were increased by the first cobalt addition; therefore some other mechanism of magnetization, presumably domain wall motion, existed in the beginning, and its contribution to μ' was decreased by more than the rotational contribution was increased.

539.2 : 538.2

3084 UNIFORM ROTATIONAL FLUX REVERSAL OF FERRITE TOROIDS. E.M.Gyorgy and F.B.Hagedorn.

J. appl. Phys., Supplement to: Vol.30, No.4, 308S-309S (April, 1959).

A model is presented for the high-speed uniform rotational reversal of ferrite toroids. This model eliminates the prohibitively high demagnetizing energy usually associated with uniform rotation in toroids. Analysis of the model, to a very good approximation, leads to results identical with those obtained from uniform rotation in isotropic thin films. Experimental confirmation of a high-speed switching mode in ferrite toroids is given.

539.2 : 538.2 : 621.374.32 : 621.318.12

3085 EVALUATION OF NEW HIGH-SPEED MAGNETIC FERRITE SYSTEM FOR USE IN COMPUTER COMPONENTS. B.R.Eichbaum.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 49S-52S (April, 1959).

Present-day computer speeds are limited by the magnetic components utilized in their construction. Such components have been fabricated from square loop ferrites of the $MgO.MnO.Fe_2O_3$ system. Since such materials limit the speed at which the computers can operate, a new ferrite system, namely, the $CdO.MnO.Fe_2O_3$ system, was studied and has been proven feasible for many new high-speed applications. Some of the compositions of this new system exhibiting square hysteresis loops have switching constants as low as 0.200 Oe μsec. Such materials in comparison with those of the $MgO.MnO.Fe_2O_3$ system have a much lower coercive force, require lower driving currents, and have a flux reversal or switching time which is five times as fast. These materials have been used in fast switching multipath elements and matrix switch cores. The operation of such elements is described.

539.2 : 538.2 : 621.374.32 : 621.318.12

3086 REVERSIBLE COMPONENT OF MAGNETIZATION. R.W.McKay.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 56S-57S (April, 1959).

A method of nondestructive sensing of a ferrite-core memory has been suggested which depends on the variation of the reversible

component of magnetization with the state of the core. In the work reported here, measurements of this reversible component were made for two types of cores. It was found that the reversible component varies nearly three to one between the remanent state and the demagnetized state. The effects of finite core-wall thickness and of flux-leakage are discussed.

539.2 : 538.2

3087 MAGNETIC PROPERTIES OF SOME FERRITE MICROPOWDERS. A.E.Berkowitz and W.J.Schuele.

J. appl. Phys., Supplement to: Vol.30, No.4, 134S-135S (April, 1959).

Micropowders of stoichiometric copper, nickel, and cobalt ferrites were prepared by low temperature ($< 800^\circ$C) treatment of the coprecipitated metal oxalates. The magnetic properties of each ferrite were determined as functions of particle or crystallite size in the range from 70 to > 2000 A. Particle sizes were determined from x-ray line broadening from electron micrographs. The micropowders exhibited superparamagnetic, single domain, or multidomain behaviour depending on the particle size. The critical size for single domain behaviour, depending on composition, was between 300 and 700 A. In this size range, high coercive force and remanence were observed in spite of appreciable sintering of the particles in some cases. The remanence values and the magnitude and temperature dependence of the coercive force indicated that magnetocrystalline anisotropy determined the properties of the single domain particles The magnetic properties of the very small particle size samples showed the large temperature dependence characteristic of superparamagnetism. Quenched and slowly cooled copper ferrite micropowders were prepared with similar particle size. The remanence and coercive force of the quenched samples were much lower than those of the slowly cooled samples. This indicated different critical sizes in these two types of copper ferrite. This could be due to the difference in either the moments or the magnetocrystalline anistropy.

539.2 : 538.2 : 538.56 : 621.375.9

MICROWAVE AND LOW-FREQUENCY OSCILLATIONS DUE TO RESONANCE INSTABILITIES IN FERRITES. See Abstr. 2448

539.2 : 538.2

3088 MAGNETIC PROPERTIES OF THE RARE EARTH GARNETS. R.Pauthenet.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 290S-292S (April, 1959).

The magnetic properties, in static fields, of the rare earth garnets are described. The Néel molecular field theory of ferrimagnetism is extended to treat three sublattices of magnetic ions and is shown to account quantitatively for the observed properties. At low temperature, the magnetic moments of those rare earth ions which have nonzero orbital angular momentum, are much less than the moments of the free ions. This is due to the quenching of the moments of the rare earth ions by the crystalline field.

539.2 : 538.2

3089 MAGNETIC PROPERTIES OF THE MIXED GARNETS $(3-x)Y_2O_3.xGd_2O_3.5Fe_2O_3$.

E.E.Anderson, J.R.Cunningham, Jr and G.E.McDuffie.

Phys. Rev., Vol.116, No.3, 624-5 (Nov. 1, 1959).

Polycrystalline garnets of this form were prepared for several values of x ranging from 0 to 3. Lattice constants vary linearly from 12.374 ± 0.005 A for yttrium–iron garnet ($x = 0$) to 12.463 ± 0.005 A for gadolinium–iron garnet ($x = 3$). Magnetic moments were measured from 77° to 580° K. For $0 < x < 0.73$, the magnetization decreases as x increases, the decrease being more pronounced at low temperatures. At $x \sim 0.73$, a compensation point occurs near absolute zero. This compensation point appears at increasingly higher temperatures as x increases beyond 0.73, until it reaches $\sim 287^\circ$K for $x = 3$. The magnetic moments for the members of the series show reasonable agreement with values calculated on the basis of the Neel theory.

539.2 : 538.2

3090 MAGNETOACOUSTIC RESONANCE IN YTTRIUM IRON GARNET. E.G.Spencer and R.C.LeCraw.

J. appl. Phys., Supplement to: Vol.30, No.4, 149S-150S (April, 1959).

Additional information is given on the conditions under which magnetoacoustic resonance is observed in polished single crystal spheres of yttrium iron garnet.

539.2 : 538.2

3091 MAGNETIC ANNEALING OF YTTRIUM IRON GARNET. B.A.Calhoun.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 293S-294S (April, 1959).

At -195°C the hysteresis loops of certain yttrium iron garnet cores are strongly affected by a large magnetic field applied as the cores are cooled from room temperature. In order for this magnetic annealing effect to occur, the d.c. resistivity at room temperature must be less than 10^9 ohm cm. The hysteresis loops, permeability and pulse response of these cores have been measured at -195°C. The magnetic behaviour of the annealed cores at this temperature can be explained qualitatively by assuming that the domain walls do not move under the influence of magnetic fields less than a critical value.

539.2 : 538.2

3092 TEMPERATURE-DEPENDENT LAG IN POLYCRYSTALLINE YTTRIUM-IRON GARNET. D.J.Epstein and B.Frackiewicz.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 295S-296S (April, 1959).

Certain samples of polycrystalline yttrium-iron garnet are characterized by a room-temperature permeability spectrum having two regions of dispersion, one at microwaves, the other at r.f. frequency. The former dispersion is identified as gyromagnetic in origin. The r.f. dispersion, which exhibits a temperature-activated shift to lower frequency with decreasing temperature, appears due to an electron-diffusion controlled domain-wall relaxation. The activation energy for the process is 0.38 eV.

539.2 : 538.2

3093 SOME ELECTRICAL AND MAGNETIC PROPERTIES OF GARNETS. E.E.Anderson.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 299S-300S (April, 1959).

Polycrystalline specimens have been prepared of yttrium-iron garnet (YIG) and substituted garnets of the forms

$$3Y_2O_3.(5-x)Fe_2O_3.xGa_2O_3 \text{ and } (3-x)Y_2O_3.xR_2O_3.5Fe_2O_3,$$

where R represents a rare earth element. Measurements have been made of lattice constants, magnetic moments, d.c. conductivity, permittivity, and permeability. The permeability and magnetic losses were measured from d.c. to 2 kMc/s. Density has a large effect on the low-frequency initial permeability; values varied from 14 to 170 for the YIG samples studied. Nominal room temperature properties of YIG are: $a = 12.374 \pm 0.005$ A; $\mu_1'/\mu_0 \sim 70$ at 1 Mc/s, ~ 10 at 100 Mc/s, ~ 1 at 1 kMc/s; $\rho = 10^{10}$ ohm cm; $\epsilon'/\epsilon_0 \sim 12$ at 20 Mc/s; $\mu_\beta = 6.8$ Bohr magnetons per formula weight. Gallium substitution increased the conductivity but decreased the other quantities measured. Rare earth substitutions had significant effects on the magnetic moments but produced only slight changes in the other quantities. The permeability spectrum of dysprosium-substituted YIG clearly shows a domain wall absorption peak at 400 kc/s and a spin-resonance absorption at 400 Mc/s.

539.2 : 538.2

3094 ON THE NATURE OF DEFECTS IN THE MAGNETIC STRUCTURE OF WÜSTITE. W.L.Roth.

J. appl. Phys., Supplement to: Vol.30, No.4, 303S-304S (April, 1959).

Neutron diffraction patterns from non-stoichiometric FeO specimens obtained at 290° K and 4.2° K show the presence of defects which consist of cation vacancies on octahedral sites and interstitial cations in tetrahedral sites. The average magnetic moment per cation site is much smaller than expected. Magnetization studies show a ferromagnetic remanence is present, and the hysteresis loop is displaced along the H axis. A model is proposed in which clusters of vacancy-interstitial defect complexes form superparamagnetic islands in exchange contact with the antiferromagnetic matrix.

539.2 : 538.2

3095 MAGNETIC-ION INTERACTION IN $Gd_3Mn_2Ge_3GaO_{12}$ AND RELATED GARNETS. M.A.Gilleo and S.Geller.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 297S-298S (April, 1959).

The existence of appreciable (c)-(a) ferrimagnetic exchange interaction in the garnet structure has been established by the observation of ferrimagnetism in $\{Gd_3\}[Mn_2](Ge_3Ga)O_{12}$. (The dodecahedral, or 24(c), ions are enclosed by { }, the octahedral, or 16(a), ions by [ ] and the tetrahedral, or 24(d), ions by ( ).) The Néel temperature is about 8° K; the $1/\chi$ versus T curve is linear for $T > 35^\circ$ K with an intercept of -6° K at $1/\chi = 0$ and a Curie constant of $5.6 \times 10^{-5} \mu_B$ deg/Oe per formula unit. The magnetic moment at 0° K probably corresponds to

$$3n_B\{Gd^{3+}\} - 2n_B[Mn^{3+}] = 11\ \mu_B$$

because the moments observed at temperatures between 4.2 and 1.5° K extrapolate to not less than $9.6\ \mu_B$ at 0° K. The moment decreases for the compositions, $\{MnGd_2\}[Mn_2](Ge_3)O_{12}$ and $\{CaGd_2\}[Mn_2](Ge_3)O_{12}$, in that order. In these three cases the $1/\chi$

versus T curves are concave downward below 20°K, as would be expected in the case of ferrimagnetism. No spontaneous magnetization is observed in $\{MnY_2\}[Mn_2](Ge_3)O_{12}$ and $\{CaY_2\}[Mn_2](Ge_3)O_{12}$ down to 1.3°K. For these compounds the $1/\chi$ versus T curve is concave upward below 20°K as would be expected for a weak (a)-(a) antiferromagnetic interaction. Only a very weak (c)-(a) interaction is present in the first case as a consequence of one-third occupancy of dodecahedral sites by Mn^{3+} ions.

539.2 : 538.2

3096 THE INTERACTION OF MAGNETIC IONS IN $Gd_3Mn_2Ge_3GaO_{12}$ AND RELATED GARNETS.
M.A.Gilleo and S.Geller.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 187-90 (July, 1959).

The existence of appreciable (c)–(a) ferrimagnetic exchange interaction in the garnet structure has been established by the observation of ferrimagnetism in $\{Gd_3\}[Mn_2](Ge_3Ga)O_{12}$. The Neel temperature is about 8°K; the $1/\chi$ versus T curve is linear for $T > 35$°K with an intercept of −8°K at $1/\chi = 0$ and a Curie constant of 5.6×10^{-3} μ_B deg. per Oe per formula unit. The magnetic moment at 0°K probably corresponds to $3n_B\{Gd^{3+}\} - 2n_B[Mn^{4+}] = 11$ μ_B, because the moments observed at temperatures between 4.2 and 1.5°K extrapolate to not less than 9.6 μ_B at 0°K. The moment decreases for the compositions $\{MnGd_2\}[Mn_2](Ge_3)O_{12}$ and $\{CaGd_2\}[Mn_2](Ge_3)O_{12}$ in that order. In these three cases the $1/\chi$ versus T curves are concave downward below 20°K, as would be expected in the case of ferrimagnetism. No spontaneous magnetization is observed in $\{MnY_2\}[Mn_2](Ge_3)O_{12}$ and $\{CaY_2\}[Mn_2](Ge_3)O_{12}$ down to 1.3°K. For these compounds the $1/\chi$ versus T curve is concave upward below 20°K as would be expected for a weak (a)–(a) antiferromagnetic interaction. Only a very weak (c)–(a) interaction is present in the first case as a consequence of one-third occupancy of dodecahedral sites by Mn^{3+} ions.

539.2 : 538.2

3097 EVIDENCE FOR TRIANGULAR MOMENT ARRANGEMENTS IN $MO.Mn_2O_3$. I.S.Jacobs.
J. appl. Phys., Supplement to: Vol.30, No.4, 301S-302S (April, 1959).

Ferrimagnetic spinel-type compounds frequently have lower spontaneous magnetizations than predicted by the simple Néel model, with tetrahedral A-site moments antiparallel to octahedral B-site moments. Yafet and Kittel suggested triangular moment arrangements, in which the moments of one kind subdivide into two groups making angles with each other. A linear increase in net magnetization with field at high field and low temperature is expected for the triangular arrangement but not for the antiparallel ferrimagnetic one. Measurements are reported of magnetization curves at 4.2°K in pulsed fields up to 140 kOe on compounds of the form $MO.MN_2O_3$ where M is Mn, Co, Zn, and mixtures thereof A high field susceptibility is observed in these, and is absent in Fe_2O_4, thus supporting a triangular model and directly measuring the strength of the B-B interaction. The observed composition dependence of the spontaneous moment and the high field susceptibility are in approximate agreement with a simple molecular field model. The spontaneous moment of Mn_2O_4 is 1.56 ± 0.04 Bohr magneton/molecule, with the B-site moments subdivided into groups at angles. From a comparison with high-temperature susceptibility data, it is suggested that the net A-site moment is dominant.

539.2 : 538.2

3098 MICROWAVE FARADAY ROTATION IN ANTIFERROMAGNETIC MnF_2. A.M.Portis and D.Teaney.
Phys. Rev., Vol. 116, No. 4, 838-45 (Nov. 15, 1959).

Microwave Faraday rotation was observed in MnF_2 from 30° up to 300°K. The antiferromagnetic resonance frequency is computed from the rotation measurements below the Néel point. The results are in good agreement with direct observation of the antiferromagnetic resonance and molecular field theory extrapolations except close to the transition where evidence for magnetic clustering is found. The Kramers–Kronig relations are applied to antiferromagnetic media and it is shown that the Faraday rotation depends both on the shift of the resonance with field and on very small field-induced intensity changes which are present. A study of Faraday elliptiticy establishes the need for using terms in the equation of motion which relax the magnetization toward the instantaneous field direction.

539.2 : 538.2

3099 EVIDENCE FOR ANTIFERROMAGNETISM IN $CoBr_2.6H_2O$. H.Forstat, G.Taylor and R.D.Spence.
Phys. Rev., Vol. 116, No. 4, 897-8 (Nov. 15, 1959).

An antiferromagnetic-paramagnetic transition was observed in a single crystal of $CoBr_2.6H_2O$ by using the proton resonance technique and by measuring the heat capacity in the temperature range 1.65-5.05°K. The Néel temperature, obtained by the magnetic measurement is 3.08°K while the heat capacity measurement gave 3.07°K. The entropy change associated with the transition was calculated from the heat capacity data and yielded 1.42 cal/mole deg. The contribution to the entropy change above the Néel temperature was approximately 38% of the total entropy change, which indicates a rather slow diminution of the short-range ordering of the Co^{++} spins.

539.2 : 538.2

3100 THE QUANTUM THEORY OF THE SPONTANEOUS MAGNETIZATION OF FERRIMAGNETICS, ANTI-FERROMAGNETICS AND THIN FILMS WITH ARBITRARY SPIN AT HIGH TEMPERATURES. L.Valenta.
Czech. J. Phys., Vol. 9, No. 1, 29-36 (1959).

Van Vleck's modification (1932) of the Heisenberg theory of ferromagnetism is generalized for substances with an arbitrary number of sub-lattices and with arbitrary spin per atom. The exchange part of the energy operator is formulated by means of "rotated" spin operators. The theory contains the quantum-mechanical generalization of non-quantum theories given by Néel and later generalized by Yafet and Kittel (1952). It also contains the theory of thin films proposed recently by the author (Abstr. 8303-4 of 1959). The magnetization laws are completely analogous to the relations derived from the theory of molecular fields. The constants of the molecular fields are interpreted by means of exchange integrals. For the special case of spin $S = \frac{1}{2}$, the theory agrees with the results of Vlasov and Ismuchametov (1954) for ferrimagnetics and antiferromagnetics, and with the author's for thin films.

539.2 : 538.2

3101 SYMMETRY OF MAGNETIC STRUCTURES.
L.M.Corliss and J.M.Hastings.
J. appl. Phys., Supplement to : Vol. 30, No. 4, 279S (April, 1959).

Refers to work published elsewhere, in which the use of space groups in the determination of magnetic structure is illustrated by reference to two recently discovered antiferromagnetic compounds, chalcopyrite ($CuFeS_2$) and chromium nitride (CrN).

539.2 : 538.2

3102 ANTIFERROMAGNETIC MAGNON DISPERSION LAW AND BLOCH WALL ENERGIES IN FERROMAGNETS AND ANTIFERROMAGNETS. R.Orbach.
J. appl. Phys., Supplement to: Vol. 30, No. 4, 233S-234S (April, 1959).

The exact eigenstates of the exchange Hamiltonian

$$H = 2J \sum_l (S_l . S_{l+1} - \tfrac{1}{4})$$

are found for short chains of 4, 6, 8, and 10 atoms of spin $\frac{1}{2}$. A linear dispersion law for magnons in an antiferromagnet is exhibited by the energy spectrum. The periodic boundary conditions are then removed and the ends of the chain held fixed, both parallel or antiparallel. The energy of the 180° Bloch wall is computed and compared with the classical result. It is found that the semiclassical ferromagnetic wall is a good approximation to the exact wall. The energy of the semiclassisal antiferromagnet wall is not a very good approximation to the exact wall energy, but the semiclassical energy appears to have the correct dependence on the wall thickness.

539.2 : 538.2

3103 TRANSITION FROM THE ANTIFERROMAGNETIC INTO THE FERROMAGNETIC STATE IN $CoSO_4$.
A.S.Borovik-Romanov and N.M.Kreines.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1053-5 (Oct., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 4, 734-6 (April, 1959).

$CoSO_4$ goes into an antiferromagnetic state at 12°K. At 4.2°K measurements of the moment along one axis show a transition to the ferromagnetic state at 12 kOe. It is suggested that this is the first ionic crystal where such a transition has been observed at a relatively weak field. D.J.Oliver

539.2 : 538.2

3104 INTERNAL CONSISTENCY OF THE HEISENBERG–DIRAC MODEL FOR ANTIFERROMAGNETISM.
J.S.Smart.
J. Phys. Chem. Solids, Vol. 11, No. 1-2, 97-104 (Sept., 1959).

An attempt is made to investigate the internal consistency of

the Heisenberg–Dirac model for antiferromagnets with nearest-neighbour interactions only. The Bethe–Peierls–Weiss approximation and the results of Brown and Luttinger (Abstr. 460 of 1956) are used to obtain relations between the Néel temperature and the exchange integral, J, and between the susceptibility at the Néel temperature and J. By combining these relations with experimental values of T_N and $\chi(T_N)$ for a given compound, two distinct values of J can be deduced. These values should agree if the theory is internally consistent. Comparisons have been made with experiment data on six antiferromagnetic compounds which seem to satisfy the nearest-neighbours-only restriction. The agreement is about as good as could be expected, considering the estimated experimental error. Approximate values of $|J|/k$ deduced for the compounds MnF_2, FeF_2, $LaFeO_3$, $LaCrO_3$, $KFeF_3$ and $KCoF_3$ are 1.8, 3.0, 27, 28, 6.0 and 12°K respectively.

539.2 : 538.2

3105 ANTIFERROMAGNETIC LINEAR CHAIN. L.R.Walker.

Phys. Rev., Vol. 116, No. 5, 1089-90 (Dec. 1, 1959).

Orbach's integral equation (Abstr. 4777 of 1959) which leads to the value of the ground-state energy of an anisotropic antiferromagnetic linear chain of spins, $S = \frac{1}{2}$, has been solved. The result is then expanded in powers of the anisotropy parameter. In this form it corresponds to the result of a perturbation calculation, the transverse part of the Hamiltonian being the perturbation. The rapid convergence of the energy series even for the isotropic case and the adequate convergence of that for the short range order, suggests that the result given by perturbation theory for the sublattice magnetization may also be satisfactory.

539.2 : 538.2

3106 LINEAR ANTIFERROMAGNETIC CHAIN. S.Rodriguez.

Phys. Rev., Vol. 116, No. 6, 1474-7 (Dec. 15, 1959).

It is shown that a linear chain consisting of a large number of atoms of spin $\frac{1}{2}$ with nearest neighbour ferromagnetic or antiferromagnetic interactions is mathematically equivalent to a one-dimensional Fermi gas with two-body forces. This equivalence is used to construct a wave-function for which the expectation value of the energy lies between the two approximations obtained by Hulthén. Also, a perturbation treatment is given which permits, in principle, the exact antiferromagnetic ground state to be obtained.

Magnetic Resonances

539.2 : 538.27

3107 STRUCTURE-SENSITIVITY OF THE HIGH-FREQUENCY N.M.R. [F^{19}] IN POWDERED ANTIFERROMAGNETIC MnF_2. J.L.Davis, G.E.Devlin, V.Jaccarino and A.L.Schawlow.

J. Phys. Chem. Solids, Vol. 10, No. 2-3, 106-9 (July, 1959).

The resonance is absent in powders obtained by precipitation whether sintered later or not. The resonance is readily observable however, in powders obtained by finely dividing single crystals. Successful attempts to modify the resonance properties by application of large pressures to powdered single crystals are described. Electron-microscope, X-ray-diffraction, and electron-spin-resonance studies were also made and support the suggestion that strains induced in the nucleation of the precipitate powder broaden the bond-sensitive n.m.r. to the point of rendering it unobservable. A single crystal of MnF_2 was subjected to a uniaxial compression in the plane perpendicular to the direction of the antiferromagnetic spin alignment. The frequency shift is linear for small pressures with $d\nu/dp = +\ 9.2 \times 10^{-21}$ kc/s per kg cm^{-2}.

539.2 : 538.27

3108 THE VARIATION OF THE FACTORS g AND g' IN THE ALLOYS Fe–Ni AS A FUNCTION OF CONCENTRATION. G.Asch.

C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1483-5 (Oct. 19, 1959). In French.

The factors have been measured at 35 600 Mc/s over the whole concentration range. The results were that the formula of Wangsness (Abstr. 592 of 1954) accurately represents the variation of g and g' with concentration in Fe–Ni and also that the g factors of Fe and Ni in Fe–Ni alloys are equal to the values in the pure metal. D.J.Oliver

539.2 : 538.27

3109 FERROMAGNETIC RESONANCE NEAR THE UPPER LIMIT OF THE SPIN WAVE MANIFOLD. C.R.Buffler.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 172S-175S (April, 1959).

Measurement of line widths of polycrystalline garnets as a function of frequency and temperature are reported. The variation of these parameters allows the uniform precessional mode to move above the $k = 0$ upper limit of the spin wave manifold so that this mode is no longer degenerate with the low k value spin wave states. When this occurs the line width undergoes a radical change, since these low k states can no longer take place in the relaxation process. When the uniform precession is thus "outside" the manifold, the behaviour of the line width should be attributed to the theory of Clogston, Suhl, Walker, and Anderson. When the uniform precession is "inside" the manifold, the behaviour is best described by the theory of Schlömann. It is believed that the measurements reported indicate convincingly the utility of the spin wave analysis of ferromagnetic relaxation.

539.2 : 538.27

3110 MICROWAVE RESONANCE IN HEXAGONAL FERRIMAGNETIC SINGLE CRYSTALS. H.S.Belson and C.J Kriessman.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 175S-176S (April, 1959).

The resonance conditions for a hexagonal single crystal with hard direction normal to the basal plane, and magnetocrystalline anisotropy with hexagonal symmetry in the basal plane, are presented. The anisotropy energy surface may be described by

$$E = K_0 + K_1\alpha_3^2 + K_2\alpha_3^4 + K_3\alpha_3^6 + K_4(\alpha_1^6 - 15\alpha_1^4\alpha_2^2 + 15\alpha_1^2\alpha_2^4 - \alpha_2^6).$$

From the resonance conditions and data on a single crystal of $Ba_2Co_2Fe_{12}O_{22}$ it is found that $K_1 = 1.38 \times 10^5$ erg/cm^3, $K_2 + 3/2K_3 = 1.42 \times 10^5$ erg/cm^3, and $K_4 = 1.10 \times 10^4$ erg/cm^3. These constants with the loss parameter determined from measurements of the ferromagnetic resonance line width accurately predict the initial permeability spin resonance in a partially oriented polycrystalline sample.

539.2 : 538.27

3111 FERROMAGNETIC RESONANCE IN POLYCRYSTALLINE FERRITES WITH HEXAGONAL CRYSTAL STRUCTURE. E.Schlömann and R.V.Jones.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 177S-178S (April, 1959).

A theory is developed for the shape of the ferromagnetic resonance line of polycrystalline ferrites with hexagonal crystal structure. The theory is applicable if the anisotropy field is much larger than the saturation magnetization. It predicts the occurrence of several absorption peaks whose locations and intensities depend on the magnitudes of the various anisotropy constants. For intermediate values of the anisotropy constants two absorption peaks should occur on the low-field side of ω/γ if $K_1 < 0$; one peak should occur on each side of ω/γ if $K_1 > 0$. Experimental results on various hexagonal compounds are in good qualitative agreement with the theory.

539.2 : 538.27

3112 FERROMAGNETIC RESONANCE g FACTOR TO ORDER $(kR_0)^3$. J.E.Mercereau.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 184S-185S (April, 1959).

The static approximation, $\nabla \times H = 0$, for the normal modes of a nonconducting ferromagnetic sphere can be improved in an iterative fashion by calculating the displacement current generated by the motion of the "static" field and using this current as the source of vorticity in the next higher approximation to the actual field. This procedure has been carried out to $(kR_0)^3$ for the "uniform" mode of ferromagnetic resonance.

539.2 : 538.27

3113 SURFACE-INDEPENDENT SPIN-WAVE RELAXATION IN FERROMAGNETIC RESONANCE OF YTTRIUM IRON GARNET. R.C.LeCraw and E.G.Spencer.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 185S-186S (April, 1959).

In contrast to the ferromagnetic resonance line width ΔH, which depends strongly upon surface polish, the "line width" ΔH_k of a z-directed spin wave is shown to be surface independent. This permits observation of a relaxation process which appears to be determined primarily by collisions between thermally excited spin waves

rather than by a volume or surface distribution of magnetic inhomogeneities. In yttrium iron garnet ΔH_k is observed to be 0.10 Oe at room temperature and to increase monotonically with increasing temperature. The 0.10 Oe corresponds to a relaxation time of 1.14 μsec. It is believed this is the narrowest line width yet indicated for a ferromagnetic material.

539.2 : 538.27

3114 FERROMAGNETIC RESONANCE OF IRON WHISKER CRYSTALS. D.S.Rodbell.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 187S-188S (April, 1959).

The ferromagnetic resonance absorption characteristics of iron single crystals have been examined between −196 and 850°C. The selected crystals has ⟨100⟩ growth directions, and their square cross-sections were bounded by {100} crystal planes: They were typically 10 μ on a side, but sizes ranging from 2 to 40 μ have been examined. Resonance absorption was observed using standard techniques with the d.c. magnetic field parallel to the length of the whisker. The microwave energy penetrates only a small fraction of the volume due to eddy current limitation. Two resonance modes were observed, one driven by the uniform microwave magnetic field, the other by its curl component. The data yield for the spectroscopic splitting factor, g, a temperature and frequency independent value of 2.05 ± 0.01. The exchange stiffness parameter, A, determined in a self-consistent way with this splitting factor, is $25 \pm 5 \times 10^{-7}$ erg/cm at 20°C.

539.2 : 538.27

3115 DIRECT OBSERVATION OF SPIN WAVE RESONANCE. M.H.Seavey, Jr and P.E.Tannenwald.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 227S-228S (April, 1959).

Resonance due to standing spin waves has been observed in thin films of Permalloy. The results are interpreted in terms of the Kittel spin pinning boundary condition and an ω versus k dispersion relation for good conductors. The method leads to a determination of the exchange constant subject to film thickness uncertainty but to a precise determination of the temperature variation of the exchange constant.

539.2 : 538.27

3116 FINE STRUCTURE IN THE DECLINE OF THE FERROMAGNETIC RESONANCE ABSORPTION WITH INCREASING POWER LEVEL. E.Schlömann.

Phys. Rev., Vol. 116, No. 4, 828-37 (Nov. 15, 1959).

A theory of ferromagnetic resonance at high signal powers is developed. The stationary response at high power levels is investigated for the case in which the unstable spin waves have the same frequency as the applied signal. It is found that a fine structure should be superimposed on the general decline of the resonance absorption with increasing power level. This fine structure arises from the discrete nature of the spin-wave spectrum. It should be observable even if the frequency separation of adjacent spin-wave modes is much smaller than the inverse of their relaxation times. The fine structure appears as a series of kinks superimposed on the general decline of the resonance absorption with increasing power level. The separation of subsequent kinks increases with decreasing sample volume and increasing exchange field. An interpretation of experimental data along the lines suggested should yield information about the strength of the exchange coupling.

539.2 : 538.27

3117 EXCHANGE EFFECTS IN FERROMAGNETIC RESONANCE. M.A.Ginsburg.

Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 1045-7 (Oct., 1958). In Russian.

English translation in: Soviet Physics—JETP (New York) Vol. 35(8), No. 4, 730-1 (April, 1959).

A simple dispersion law for TEM waves and spin-waves is derived for ferromagnetic resonance, taking into account both relativistic and exchange interaction. S.A.Ahern

539.2 : 538.27 : 538.56 : 621.372.832.8

3118 LOW-LOSS GYROMAGNETIC COUPLING THROUGH SINGLE CRYSTAL GARNETS. R.W.DeGrasse.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 155S-156S (April, 1959).

Describes methods of synthesizing filters and gyrators using strong coupling of a small volume of ferrimagnetic material to an electromagnetic circuit. The small volume of material is treated as a lumped element resonator and it is shown that energy can be coupled through this resonator with low loss. The device uses the material for low-loss transmission of microwave energy. The practical realization of devices using this principle depends upon strong coupling of the material to the circuit and the use of "low-loss" materials such as single crystal garnets. The synthesis leads to the design of physically small electronically tunable filters, compact circulators and isolators. Such techniques may also be useful for the realization of low-frequency lumped element devices. Calculations and preliminary tests indicate that devices of this type will lead to the practical realization of solid state TR cells.

539.2 : 538.27

3119 EXCHANGE RESONANCES IN GADOLINIUM IRON GARNET NEAR THE MAGNETIC COMPENSATION TEMPERATURE. S.Geschwind and L.R.Walker.

J. appl. Phys., Supplement to: Vol.30, No.4, 163S-170S (April, 1959).

The theory of ferrimagnetic resonance in a system of two sublattices is reviewed with emphasis upon the behaviour near the compensation point. Experimental studies have been made on the gadolinium-iron garnet system in a temperature region of about 30°C which included the compensation point. The "normal" and "exchange" modes were observed and their field dependence upon temperature above and below compensation found to be in good agreement with that predicted. From the data near compensation it was possible to derive values for the effective field acting on the gadolinium sublattice at compensation, for the difference in gyromagnetic ratios of the iron and gadolinium sublattices, and for the sum of the anisotropy fields on the latter. Microwave evidence is presented for the existence of antiferromagnetic domains at the compensation temperature.

539.2 : 538.27 : 538.56

3120 HARMONIC RESONANCES IN SMALL FERRIMAGNETIC ELLIPSOIDS. F.R.Morgenthaler.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 157S-159S (April, 1959).

This paper considers the response of the magnetization of a small ferrimagnetic ellipsoids to spatially uniform r.f. magnetic fields of one or more frequencies. The analysis is applicable to other excitations but only a few pertient cases are considered in this paper. Some of the work duplicates that of Pippin [Proc. Inst. Radio Engrs, Vol. 44, No. 8, 1054 (Aug., 1956)], Jepsen, and others, but the approach to the problem is quite different and allows one to extend previous results, as well as to derive new ones. The effects of symmetry planes and anisotropy are considered as well as the permeability tensor for the general ellipsoid when modulation terms of the magnetization are neglected.

539.2 : 538.27

3121 COUPLING OF THE MAGNETOSTATIC MODES. P.C.Fletcher and I.H.Solt, Jr.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 181S-182S (April, 1959).

Interaction has been observed between magnetostatic modes due to propagation effects and surface irregularities. The interaction may be characterized by a resonant field shift and intensity exchange similar to the response behaviour of two tuned coupled circuits. The mechanisms causing the interaction are discussed.

539.2 : 538.27

3122 OBSERVATIONS ON LINE WIDTH IN FERRIMAGNETIC RESONANCE. R.L.White.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 182S-183S (April, 1959).

Line widths as a function of magnetostatic mode have been measured for Mn–Zn ferrite and YIG spheres. The data are in conflict with the predictions of current scattering type theories of magnetic relaxation. The nature and significance of the conflict is discussed, and qualitative comments on modification of the theory made.

539.2 : 538.27

3123 INFLUENCE OF EXCHANGE INTERACTION ON PARAMAGNETIC RELAXATION TIMES.

J.P.Goldsborough, M.Mandel and G.E.Pake.

Phys. Rev. Letters, Vol. 4, No. 1, 13-15 (Jan. 1, 1960).

An investigation of T_2, from line width, and T_1 by saturation, for resonant frequencies 10 and 24 kMc/s and temperature range 1.5°K to room temperature for several solid free radicals (DPPH, BDPA and Wurster's blue) and for DPPH in solution in polystyrene.

In the solids $T_1 \cong T_2$ and they are independent of temperature. In the solution $T_1 > T_2$, T_2 is concentration dependent and T_1 is concentration and temperature dependent. The results are discussed in terms of relaxation via the "exchange reservoir" to the lattice. This process is controlled by the Zeeman to Exchange step except for dilute samples where direct relaxation to the lattice dominates. At liquid helium temperatures an effect is found similar to antiferromagnetic Curie points. J.G.Powles

539.2 : 538.27

3124 SECOND MOMENT OF THE PARAMAGNETIC ABSORPTION CURVE WHEN THE SPIN MAGNETISM IS NOT PURE. U.Kh.Kopvillem.
Zh. eksper. teor. Fiz., Vol.34, No.4, 1040-2 (April, 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol.34(7) No.4, 719-21 (Oct., 1958).

Extends the work of Van Vleck (Abstr. 949 of 1949) to the case where the g-factor is a tensor. The calculations are relevant to the study of double nitrates and ethyl sulphates. D.J.Oliver

539.2 : 538.27

3125 SATURATION OF PARAMAGNETIC SPINS BY 13 Mc/sec ULTRASONIC PHONONS.
R.D.Mattuck and M.W.P.Strandberg.
Phys. Rev. Letters, Vol. 3, No. 12, 550-1 (Dec. 15, 1959).

The paramagnetic resonance signal, at various spin resonance frequencies (ν_r), in a sound field of 13 Mc/s frequency and of variable power has been compared with that obtained without the sound field for (a) ruby (9 Mc/s $< \nu_r <$ 21 Mc/s); (b) dilute Cr^{+++} ions in MgO (ν_r = 13.0, 18.2 and 195 Mc/s); and (c) γ-ray dosed quartz (10.8 $< \nu_r <$ 20.6 and ν_r = 175 Mc/s). In case (a), no effect was either expected or found. In case (b), the effect was 10^7 times less than expected theoretically, possibly as a result of lattice distortion by Cr^{+++} ions. In case (c), a very wide bandwidth (>176 Mc/s) is found, in agreement with microwave phonon measurements; thermal heating by the sound is not felt to cause this. L.Mackinnon

539.2 : 538.27

3126 PARAMAGNETIC RESONANCE ABSORPTION IN NEPTUNIUM HEXAFLUORIDE.
C.A.Hutchison, Jr. and B.Weinstock.
J. chem. Phys., Vol. 32, No. 1, 56-61 (Jan., 1960).

The paramagnetic resonance absorption of crystalline NpF_6 was studied at 3 cm wavelength and at the boiling point of liquid He. The data were fitted to the spin Hamiltonian, $\mathcal{H} = \beta H \cdot g \cdot S + I \cdot A \cdot S$. The parameters are isotropic within the errors of the measurements, with $g = -0.604$ and $|A/hc| = 0.1100\ cm^{-1}$. These results are interpreted in terms of the configuration f^1 perturbed by spin-orbit coupling and an octahedral molecular potential. The relationships of these results to optical data and measurements of magnetic susceptibility for the same substance are discussed. Hyperfine structure due to F is observed and is anisotropic.

539.2 : 538.27

3127 PARAMAGNETIC RESONANCE OF OXYGEN IN ALKALI HALIDES. W.Känzig and M.H.Cohen.
Phys. Rev. Letters, Vol. 3, No. 11, 509-10 (Dec. 1, 1959).

Alkali halide crystals grown from the melt exhibit a paramagnetic resonance spectrum which is attributed to O_2^- substituting for a halogen ion in the lattice. The chlorides, bromides and iodides of sodium, potassium and rubidium were investigated. The concentration of the paramagnetic centres was greatly increased by heating the crystals in oxygen, and reduced by heating in other gases, or vacuum. The g tensor has orthorhombic symmetry and its experimental values fit fairly well with those calculated taking reasonable values for the separation of the electronic levels of O_2^-, and a spin-orbit coupling several times smaller than in atomic oxygen. The molecular axis appears to be along [1$\bar{1}$0] in the potassium and rubidium halides and along [001] in the sodium salt. J.M.Baker

539.2 : 538.27

3128 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF ALANINE: SECOND-ORDER EFFECTS IN FREE RADICAL RESONANCES.
I.Miyagawa and W.Gordy.
J. chem. Phys., Vol. 32, No. 1, 255-63 (Jan., 1960).

The electron spin resonance of single crystals of *l*- and d-alanine were observed at T = 300°K and analysed for different orientations of the crystal in the magnetic field and at several microwave frequencies ranging from 9 to 34 kMc/s. The stable free radical produced by the irradiation is proved to be of the form CH_3CHR, where R is a group which has no nuclei with detectable coupling. The hydrogens of the CH_3 group of the radical are shown to have equivalent, isotropic coupling of 26 gauss each, essentially independent of the frequency of observation. This CH_3 group coupling is interpreted as arising from s orbital spin density of the hydrogens, via hyperconjunction. The hydrogen of the CH group has both an isotropic, Fermi term, A_f = 20 gauss, arising from s orbital density on the hydrogen, and an anisotropic term A_μ = 7 gauss arising from dipole–dipole interaction of the proton moment with the electron spin density, ρ_C, on the carbon. Although the signs of A_f and A_μ could not be learned, they are shown to be of opposite sign. Hence the spin density is negative on either H or C. Principal values of the CH coupling are A_1 = 7 gauss, $A_2 = A_3$ = 27 gauss. The value of ρ_C is shown to be 0.80 approximately. For certain orientations of the crystal the CH coupling becomes equal to the CH_3 coupling, and a quintet pattern is observed. Interesting second-order transitions are observed which for the [001] orientation become in the region of 24 kMc/s as strong as the normal first-order transitions. A general theory is developed which accounts satisfactorily for these second-order effects which are probably of consequence in the electron spin resonance patterns of numerous other free radicals trapped within solids.

539.2 : 538.27

3129 PARAMAGNETIC RESONANCE ABSORPTION IN TWO COPPER SALTS AT WAVELENGTHS OF 5.4 mm AND 6.6 mm. K.Ôno and M.Ohtsuka.
J. Phys. Soc. Japan, Vol. 13, No. 2, 206-9 (Feb., 1958).

Paramagnetic resonance absorption in single crystals of $CuSO_4.5H_2O$ and $K_2CuCl_4.2H_2O$ has been investigated at wavelengths of 5.4 mm and 6.6 mm. The shapes of absorption lines vary remarkably with orientation of the crystal in the magnetic field. This is interpreted in terms of exchange interaction between copper ions. The line shapes are compared with result calculated recently by Anderson. And then the exchange frequencies are estimated to be 1.0×10^{10} and 1.1×10^{10} for $CuSO_4.5H_2O$ and $K_2CuCl_4.2H_2O$ respectively.

539.2 : 538.27

3130 PARAMAGNETIC ABSORPTION IN PARALLEL FIELDS AT 9.3×10^9 c/s IN THE SALTS $Fe(NH_4)(SO_4)_2.12H_2O$ AND $Fe(NO_3)_3.9H_2O$. V.A.Kutuzov.
Zh. eksper. teor. Fiz., Vol. 35, No. 5(11), 1304 (Nov., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 35(8), No. 5, 910 (May, 1959).

539.2 : 538.27

3131 PARAMAGNETIC RESONANCE SPECTRA OF CHROMIUM AND MANGANESE IN THE SPINEL STRUCTURE. R.Stahl-Brada and W.Low.
Phys. Rev., Vol. 116, No. 3, 561-4 (Nov. 1, 1959).

The paramagnetic resonance spectrum of Cr^{3+} was measured on the single crystal of ruby spinel $MgAl_2O_4$ at the wavelengths of 3 cm, 1.2 cm, and 8.6 mm. The spectrum confirms that Cr^{3+} is at a B site and can be described with an axial spin Hamiltonian $S = \frac{3}{2}$, $2D = 0.990 \pm 0.005\ cm^{-1}$, $g_\parallel = 1.986 \pm 0.001$, $g_\perp = 1.989 \pm 0.002$. The paramagnetic resonance spectrum of Mn^{2+} was measured on the single crystal of $ZnAl_2O_4$ at 3 cm. The spectrum consists of six nearly isotropic lines with $A = 74.9 \pm 0.5 \times 10^{-4}\ cm^{-1}$, $g = 2.000_0 \pm 0.001$. The cubic or axial splitting was less than $8 \times 10^{-4}\ cm^{-1}$. The spectrum is indicative that Mn^{2+} is located at an A site.

539.2 : 538.27

3132 PARAMAGNETIC RESONANCE OF S-STATE IONS IN STRONTIUM CHLORIDE. W.Low and U.Rosenberger.
Phys. Rev., Vol.116, No.3, 621-3 (Nov. 1, 1959).

Paramagnetic resonance spectra were observed of Mn^{2+}, Gd^{3+}, and Eu^{2+} in single crystals of strontium chloride grown from the melt. The Mn^{2+} shows a very small cubic-field splitting $a < 1 \times 10^{-4}\ cm^{-1}$ and a hyperfine structure constant of $A = 81.2 \times 10^{-4}\ cm^{-1}$, indicating some covalent bonding. The Gd^{3+} and Eu^{2+} have cubic symmetry with splitting parameters, for Gd^{3+}: $c = \pm(39.6 \pm 0.1) \times 10^{-4}\ cm^{-1}$, $d = \mp(0.2 \pm 0.1) \times 10^{-4}\ cm^{-1}$, $A^{155} = (34.5 \pm 0.3) \times 10^{-4}\ cm^{-1}$, $A^{157} = (15.5 \pm 0.3) \times 10^{-4}\ cm^{-1}$, $g = 1.995 \pm 0.001$. The smaller cubic field splittings in $SrCl_2$ compared with CaF_2 seem to favour a mechanism responsible for the cubic-field splitting which is linear in the crystal potential terms.

539.2 : 538.27

3133 TEST OF SPIN HAMILTONIAN FOR IRON^{3+} IN STRONTIUM TITANATE.
S.Aisenberg, H.Statz and G.F.Koster.
Phys. Rev., Vol. 116, No. 4, 811-18 (Nov. 15, 1959).

The applicability of a conventional spin Hamiltonian to the paramagnetic spectrum of Fe^{3+} in strontium titanate is investigated. The work was inspired by a paper by Müller (Abstr. 5908 of 1959) who found deviations from a conventional spin Hamiltonian which he attributed to covalent bonding. The spectrum is remeasured and compared with the more general theory of Koster and Statz. It is found that the conventional Hamiltonian describes the spectrum about as well, in this case, as the improved theory. The remaining discrepancies vary from crystal to crystal and are due to random distortions of the Fe^{3+} site. A rather good agreement with theory was obtained for one crystal which apparently was more perfect than the other measured samples. From perturbation theory, it is concluded that the deviations from a conventional Hamiltonian should be about 0.1 Mc/s if covalency and exchange effects can be neglected. The experimental errors in the present experiments are about 1 to 2 Mc/s. Even though for the present example it is unnecessary to resort to the improved theory, it is shown that, even in the absence of covalency, measurable deviations from a conventional spin Hamiltonian are expected in substances where the zero-field splittings and the applied magnetic field are large.

539.2 : 538.27

3134 RELAXATION EFFECTS IN A MASER MATERIAL, $K_3(CoCr)(CN)_6$. S.Shapiro and N.Bloembergen.
Phys. Rev., Vol. 116, No. 6, 1453-8 (Dec. 15, 1959).

The rate equations for the occupation of spin levels are augmented to include cross-relaxation processes. It is confirmed experimentally that the latter are important when the concentration of magnetic ions is high or two resonances have a small separation. Maser action is usually impaired under such circumstances. When experimental conditions are chosen such that cross-relaxation effects are negligible, it is shown that all spin-lattice relaxation processes for Cr^{3+} in the cyanide are proportional to the absolute temperature in the liquid helium range. The susceptibilities at both the pump and maser frequencies follow the general theoretical dependence and reach asymptotic values as a function of pump power.

539.2 : 538.27 : 538.56

COMPACT PASSIVE NONRECIPROCAL STRUCTURES FOR U.H.F. FREQUENCIES. See Abstr. 2438

539.2 : 538.27

3135 PARAMAGNETIC RESONANCE AND CRYSTAL FIELD IN TWO NICKEL CHELATE CRYSTALS. M.Peter.
Phys. Rev., Vol. 116, No. 6, 1432-5 (Dec. 15, 1959).

The splitting of the paramagnetic ground state of Ni^{2+} in a cubic field perturbed by an axial and an orthorhombic term is calculated. The crystal field can be approximated by the electrostatic field of the surrounding ions, but the close contact of these ions with the impurity makes this an uncertain approximation. The author therefore measured the paramagnetic spectrum of Ni^{2+} in a metal-organic crystal where the orthorhombic component of the crystal field is caused entirely by two far-removed dioxane molecules. (Upon replacement of the dioxane by benzene, this component disappears). A comparison between predicted and measured values is given.

539.2 : 538.27

3136 ULTRASONIC INVESTIGATION OF NUCLEAR SPIN-LATTICE RELAXATION. G.S.Verma.
Nuovo Cimento Suppl., Vol. 12, No. 1, 41-62 (1959).

A review of the effects of ultrasonic irradiation on the nuclear resonance relaxation times in ionic crystals. A rather detailed account of the theoretical background is given. The principle problem seems to be the disagreement between theory and experiment for the antishielding factor. J.G.Powles

539.2 : 538.27

3137 NUCLEAR MAGNETIC RESONANCE STUDIES OF NEUTRON-IRRADIATED ALKALI HALIDES.
J.F.Hon and P.J.Bray.
J. Phys. Chem. Solids, Vol. 11, No. 1-2, 149-69 (Sept., 1959).

Nuclear magnetic resonance techniques have been used to investigate irradiation damage in some alkali halides. The resonances of Li^7, Na^{23}, Br^{81}, and I^{127} were studied to determine the concentration and arrangement of defects in neutron-irradiated single crystals of NaI, LiI, KI and KBr. A method of analysis was developed, based on changes of line shape due to defect-induced quadrupolar effects. The experimental results are in fairly good agreement with theoretical predictions based, principally, on the methods of Seitz and Koehler (1956) and of Brinkman (Abstr. 9437 of 1934). Information has been obtained on the strength of screening in Coulomb potentials for atom–atom collisions and on the deformation of ion cores by charges external to the ions. Evidence for orientation of dislocations in preferred directions has been noted in crystals of NaI and KI.

539.2 : 538.27

3138 N.M.R. STUDY OF BONDING IN SOME SOLID BORON COMPOUNDS. A.H.Silver and P.J.Bray.
J. chem. Phys., Vol. 32, No. 1, 288-92 (Jan., 1960).

Nuclear magnetic resonance studies of B^{11} were performed in powder samples of some metal borides, boron-nitrogen compounds, borofluorides and borohydrides, and borates. The B^{11} nuclear electrical quadrupole interactions were measured and used in the Townes and Dailey approach to estimate the probable bonding electron configurations.

539.2 : 538.27 : 532.7

3139 NUCLEAR MAGNETIC RESONANCE ABSORPTION IN ISO-BUTYL BROMIDE AS A CRYSTAL AND AS A SUPERCOOLED LIQUID. J.G.Powles and J.A.E.Kail.
Proc. Phys. Soc., Vol. 73, Pt 6, 833-40 (June, 1959).

The proton magnetic resonance absorption in iso-butyl bromide ($(CH_3)_2CHCH_2Br$) in the temperature range -196° to $-115^\circ C$ was measured both in the crystalline form and as a supercooled liquid. The measurements confirm a very considerable difference in freedom of molecular motion as between the two forms indicated by earlier dielectric loss measurements. The results indicate that in the isobutyl bromide molecule one of the methyl groups is less able to rotate about its C_3 axis than the other and that therefore the stable isomer is in what may be called the gauche configuration. A severe line narrowing in the supercooled liquid centred at $-157^\circ C$ is interpreted as due to reorientation of the molecule as a whole at a rate which is in excellent agreement with dielectric loss measurement. Reorientation of the whole molecule in the crystal only occurs slowly, if at all, below the melting point. The line widths are 7.2 G and 4×10^{-4}G respectively just below the melting point.

539.2 : 538.27

3140 NUCLEAR SPIN–LATTICE RELAXATION IN METALS. A.G.Anderson and A.G.Redfield.
Phys. Rev., Vol. 116, No. 3, 583-91 (Nov. 1, 1959).

The nuclear spin–lattice relaxation time, T_1, was measured in the range of 1.1° to $4.2^\circ K$ for the metals lithium, sodium, aluminium, and copper. A combination of nuclear magnetic resonance at fixed frequency and adiabatic variation of the magnetic field was used to measure T_1 as a function of field at 0-1000 G. At fields of 100-1000 G T_1 is independent of magnetic field and inversely proportional to temperature in agreement with theory. The experimental values of the relaxation time multiplied by absolute temperature (in sec $^\circ K$) are 44 ± 2.0 for Li^7; 5.1 ± 0.3 for Na^{23}; 1.80 ± 0.05 for Al^{27}; 1.27 ± 0.07 for Cu^{63}. These values are in good agreement with previous experimental data at room temperature and above. At fields comparable with the nuclear magnetic dipole–dipole fields, T_1 is a function of applied field. The theory of relaxation in low fields is presented in an elementary form. Qualitative agreement with theory is obtained for Al^{27} and Cu^{63}; detailed agreement is obtained for Li^7 and Na^{23}.

539.2 : 538.27

3141 TEMPERATURE DEPENDENCE OF QUADRUPOLE RESONANCE FREQUENCIES UNDER CONSTANT PRESSURE. R.J.C.Brown.
J. chem. Phys., Vol. 32, No. 1, 116-18 (Jan., 1960).

The theory of the temperature dependence of pure quadrupole frequencies under constant volume conditions is modified when constant pressure conditions apply. For the case of molecular crystals the first and second derivatives of frequency with respect to temperature have been calculated assuming that (i) the quadrupole coupling constant is independent of volume, and (ii) the lattice frequencies vary linearly with temperature. These derivatives have been evaluated experimentally for the α phase of p-dichlorobenzene, and comparisons made with the theory; good agreement with previous work on the pressure dependence of quadrupole frequencies is obtained.

539.2 : 539.27

3142 NUCLEAR QUADRUPOLAR RELAXATION IN IONIC CRYSTALS. J.Kondo and J.Yamashita.

J. Phys. Chem. Solids, Vol. 10, No. 4, 245-53 (Aug., 1959).

The nuclear quadrupolar relaxation time of alkali halide crystals is investigated by the Heitler–London approximation. The Slater determinant is used which is constructed by the Hartree–Fock wave-functions of the free ions. The charge distribution around an ion is not spherically symmetrical because of mutual overlap of the atomic wave-functions of nearest-neighbour ions. Moreover, the charge distribution around an ion changes its shape during thermal vibrations of the ions, because the degree of the overlap depends upon the distance apart of the ions. Therefore, the quadrupolar interaction in alkali halide lattices is the resultant of a combination of the thermal vibration with the charge overlap. As illustrations of the theory, the quadrupolar relaxation time was computed of K^{39} and Cl^{35} in KCl, and Na^{23} in NaCl. The theoretical results are in good agreement with those of experiments. The ratio was also calculated of the quadrupolar relaxation time of the metal nucleus to that of the halogen nucleus for some alkali halide crystals. After computing the same ratio by the covalent model and the deformation model, these results are compared with the available experimental data. By using the same overlap model, a formula is developed which gives the chemical shift of ionic crystals.

539.2 : 538.27

3143 QUADRUPOLE ANTI-SHIELDING FACTOR IN COPPER. E.A.Faulkner.

Nature (London), Vol. 184, 442-3 (Aug. 8, 1959).

Measurement of nuclear resonance absorption at 5.5 Mc/s in copper subjected to elastic strain with a view to finding a change in field gradient at the copper nuclei via the electric quadrupole moment. It is shown that a previous estimate (Abstr. 9845 of 1959) of the anti-shielding factor, λ, of 60 may be too high and that $\lambda \leqslant 7$. Alternatively λ may have a very high value. J.G.Powles

MECHANICAL PROPERTIES OF SOLIDS

539.3

3144 STRESS-STRAIN MEASUREMENTS OF FACE-CENTRED CUBIC METALS AT VARIOUS TEMPERATURES. W J.Hoek and B.S.Blaisse.

Bull. Inst. Internat. Froid, Annexe 1958-1, 211-18.

Polycrystalline annealed silver, lead and aluminium were tested in the temperature range 4.2-290°K; the stress was measured with beryllium-bronze strain gauges and the strain by Moiré fringes produced by two gratings attached to the specimens. All show an increase of Young's modulus, tensile strength and ultimate elongation as the temperature is reduced. A discontinuous elongation was observed in aluminium. J.E.Caffyn

539.3

3145 HIGH TEMPERATURE DAMPING OF TANTALUM, RHENIUM, AND TUNGSTEN. R.H.Schnitzel.

J. appl. Phys., Vol. 30, No. 12, 2011-12 (Dec., 1959).

A vertical wire of Ta, Re or W was heated in vacuo to temperatures between 1000° and 2000°C, by passing alternating current through it, the ends of the wire being fixed and a pendulum bob being mounted at its mid-point. Internal friction, measured in torsional oscillations set up by means of an electromagnet, shows a peak attributable to grain-boundary relaxation (which can be eliminated by using coarse-grained specimens of Ta or W) at 1100°C in polycrystalline Ta, 1400°C in Re, and a fairly constant maximum above 1250°C in W annealed at 2000°C or higher. J.G.Oldroyd

539.3

3146 MECHANICAL DAMPING OF HEAVY ICE CRYSTALS. S.Woerner and S.Magun.

Naturwissenschaften, Vol. 46, No. 17, 509-10 (1959). In German.

Damping measurements were carried out in the frequency range 0.2-4 kc/s and the temperature range −90 to 2°C. The frequency of maximum damping, f_{max}, varied with temperature, T, according to the equation $F_{max} = f_0 \exp(-A/kT)$. The same formula applied to light ice with the same activation energy, A (suggesting that damping arises from diffusion of proton or deuteron vacancies), but with the frequency factor f_0 multiplied by 0.56 B.T.M.Willis

539.3

3147 TENSILE DEFORMATION OF SINGLE CRYSTAL OF PURE IRON AT HIGH TEMPERATURE. S.Dohi.

J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 49-55 (April, 1959).

The aspect of deformation in the single crystal plates of pure iron produced by tensile straining at high temperature, was investigated by examination of the X-ray Laue photographs and optical micrographs taken from them. The slip caused at high temperature always took place only on the {110} planes. That is, the effect of tensile straining at 100°C was the same as the one at room temperature, and it caused the double slip by {110} slip system in the crystal whose tensile axis lay in the large region of the stereographic triangle, but the one at temperature over 200°C produced the single slip on (101) plane in [111] direction, except in a crystal with the tensile axis lying on the three sides of the stereographic triangle.

539.3

3148 TENSILE DEFORMATION AND TENSILE STRENGTH OF ALUMINIUM SINGLE CRYSTAL COATED WITH OXIDE FILM. T.Mukai.

J. Sci. Hiroshima Univ. A, Vol. 22, No. 2, 99-110 (Sept., 1958).

The tensile deformation and tensile strength of the aluminium single crystal plate coated with oxide film were studied. The following facts were found: (1) When stretched lengthwise, first a weak part of the film cracks and at this moment the slips of any kind take place at this part and then this part is work-hardened, and then another part of the film cracks and so on. Thus the cracks of the oxide film are successively created not by extending their width so much, but by increasing the number of the cracks till the crystal is lengthened by about 6%. Further, if the crystal plate is lengthened more than about 6%, new cracks of the oxide film are seldom created, but the width of the existing cracks increase. (2) The appearance of the slip bands in the cracks of the oxide film is more sinuous than that of the slip bands on the crystal without oxide film. (3) Generally the tensile strength of aluminium single crystal plate increases when coated with oxide film, and the tensile strength rises as the stretching increases, till it reaches a maximum at elongation, 5-7% when it begins to decrease; after the elongation reaches about 20% further, change is small. (4) The maximum value of the increase of tensile strength caused by the coated oxide film, increases in proportion to the thickness of the film both when thicker than 1600 A and when thinner than 700 A. From these results, the tensile strength of the film and the tensile resistance originating from disturbance of the progress of slip caused by the stretching, were obtained, and their amounts were 4×10^{10} dyne/cm² and 5×10^{5} dyne/cm respectively.

539.3

3149 SLIP PATTERNS ON THE STRETCHED SINGLE CRYSTAL PLATES OF ALUMINIUM. T.Kino and T.Fujiwara.

J. Sci. Hiroshima Univ. A, Vol. 22, No. 2, 111-22 (Sept., 1958).

The slip patterns developed by stretching on the aluminium single crystal plates having certain definite crystallographic orientations such as [001], [110], [111] were examined. Comparing these patterns with the stress-strain curves obtained from the same specimens, the correspondence between the slip patterns and the stress-strain curves at various stages covering the whole range of deformation was clarified in terms of the crystallographic orientation of the single crystals. In this connection, the formation of rumple patterns, deformation band and virgin slip are also discussed.

539.3 : 538.2 : 539.2

3150 INFLUENCE OF PLASTIC DEFORMATION ON THE TIME DECREASE OF PERMEABILITY IN TRANSFORMER STEEL.

A.K.Smoliński, Z.Kaczkowski and M.Żbikowski.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 195S-199S (April, 1959).

This paper gives the results of measurements of the influence of plastic deformations in the time-decrease of permeability in hot rolled transformer steel. In the first part measurements were performed on samples rolled in a mill. The measurements showed a drop of time decrease of permeability at large elongations and a maximum at small elongations. In the second part measurements were performed on samples stretched in a tensile testing machine. The results of measurements are characterized by typical wavy shape of time decrease of permeability. The obtained results are compared with the variations of lengths of the path of impurities diffusing in the crystal lattice.

539.3

3151 SUBSTRATE DAMAGE IN FILM THICKNESS MEASUREMENT BY MULTIPLE BEAM INTERFEROMETRY.

G.D.Scott.
Nature (London), Vol. 184, 354-5 (Aug. 1, 1959).

An examination is made of the substrate damage produced on glass when channels are made with a variety of needles. Interferograms are given showing the shapes of the channels scratched in the glass when different loads are used. It is shown that plastic deformation of the glass is avoided with a sewing needle, but takes place with a high load on a gramophone needle. The softer sewing needle leads to error-free determinations. S.Tolansky

539.3

3152 SLIP PATTERNS ON THE QUENCH-HARDENED ALUMINIUM SINGLE CRYSTAL PLATES.
K.Izui, T.Kino and T.Fujiwara.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 43-7 (April, 1959).

Slip patterns on quenched aluminium single crystal plates and on furnace-cooled ones were examined by the electron microscope and compared with each other. The following differences were recognized: (1) The so-called fine slip was observed at an earlier stage of deformation for the slow cooled specimens than for the quenched ones; (2) The slip amount per band in the quenched specimens was larger than that in the furnace-cooled ones, whereas the slip distance per slip line in the quenched ones was rather smaller than in the furnace-cooled ones.

539.3

3153 INTERACTION OF DISLOCATIONS WITH AN APPLIED STRESS IN ANISOTROPIC CRYSTALS.
G. deWit and J.S.Koehler.
Phys. Rev., Vol. 116, No. 5, 1113-20 (Dec. 1, 1959).

The equilibrium shape of a dislocation segment between two pinning points in the same glide plane is calculated. The assumption is made that the dependence of the dislocation self-energy on the geometry of the dislocation line can be expressed by using an energy per unit length, E, which is a function only of the angle, θ, between the Burgers vector and the tangent to the dislocation. Only glide of the dislocation, not climb, is considered. The results obtained are compared with those for elastically isotropic crystals. It is found that the character of the dislocation shape is altered considerably if $E + d^2E/d\theta^2$ can be negative. It is suggested that the change in sign of this quantity is associated with diffusionless phase changes.

539.3

3154 INFLUENCE OF ELASTIC ANISOTROPY ON THE DISLOCATION CONTRIBUTION TO THE ELASTIC CONSTANTS. J.S.Koehler and G. deWit.
Phys. Rev., Vol. 116, No. 5, 1121-5 (Dec. 1, 1959).

See also previous abstract. Calculations of the dislocation contribution to the measured elastic constants of face-centred cubic crystals are made as follows. First, the displacement of a pinned dislocation segment under an externally applied stress is evaluated. Then the contribution to the resulting macroscopic distortion of the specimen resulting from the motion of all the dislocations present is calculated. The results are that the contributions for given dislocation arrangements increase with increasing anisotropy. For copper and lead the contributions can amount to a few percent in a pure well annealed crystal and can be as large as 10% in slightly deformed crystals. Edge dislocations are found to make about ten times larger contributions than a similar density of screw dislocations.

539.3

3155 A MORE PRECISE EVALUATION OF LONGEVITY OF A SOLID UNDER TENSION. B.Ya.Pines.
Fiz. tverdogo Tela, Vol. 1, No. 2, 265-74 (Feb., 1959). In Russian.

Consideration of crack growth by vacancy migration leads to the following equation for longevity (i.e. time taken to fail) of a solid under tensile load p_0:

$$t = [C(kT)^2E \exp(-p_0\delta^3\sqrt{n_0}/kT)]/p_0^3\delta^4D,$$

where C is a numerical constant of the order of several units, k is the Boltzmann constant, T is the absolute temperature, E is Young's modulus, δ represents the linear dimensions of the atoms in the solid, n_0 is the number of vacancies in an initial crack assumed to exist before application of the load, $D = D_0 \exp(-Q/RT)$ is the self-diffusion coefficient, Q is the self-diffusion activation energy, and R is the gas constant. A.Tybulewicz

539.3

3156 HARDENING INDUCED BY ADDITIVE COLORATION IN KCl. T.Suzuki and M.Doyama.
J. Phys. Chem. Solids, Vol. 10, No. 2-3, 77-86 (July, 1959).

The critical shear stress of KCl crystals has been measured as a function of the number of F-centres (n_F) in the range of $0\text{-}10^{18}$ cm^{-3} introduced by additive coloration. The introduction of the F-centres give a marked increase of critical shear stress σ_C as

$$\Delta\sigma_C = (3.1-0.22\,T^{\frac{1}{2}})10^{-18}n_F \text{ g/mm}^2,$$

where T is the temperature in deg K. If the coloured crystals are held in the dark below room temperature, even at nitrogen temperature, the critical shear stress increases with time until a saturation level is reached which depends upon n_F and the ageing temperature. The irradiation of the F-light enhances the rate of the process greatly. The hardening due to ageing is a reversible function of the ageing temperature. The effect of the coagulation of F-centres on the mechanical properties has also been studied. As the ageing proceeds at nitrogen temperature, the absorption curve on the shorter-wavelength side of the F-band produces a broadening and a peak at 2.78 eV. Although cold working before ageing does not produce a large effect, deformation at the coloration temperature after coloration gives rise to extensive effects on the broadening of the F-band in the above region, while no indication of the growth of complex centres is observed. A qualitative discussion of the present phenomena is given. This is based on the electronic process associated with the clustering of point defects, including the F-centres, in the vicinity of the dislocations.

539.3

3157 PERCUSSION FIGURES IN CRYSTALS.
C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 48, No. 6, 307-16 (Dec., 1958).

The impact of a hard steel sphere on the optically polished surface of a solid results in a permanent deformation of the surface and also produces fractures or rearrangements in the interior of the solid. These have been studied with crystals of quartz, calcite, barytes and felspar and also with a few polycrystalline solids. The results of the study show clearly that the nature of the percussion figure exhibited by a solid is a characteristic property of the material and is related to its inner structure and symmetry. The paper is illustrated by a series of photographs.

539.3

3158 SOLID STATE RHEOLOGICAL STUDY OF THE MECHANISM OF PARAFFIN-DETERGENT INTERACTIONS IN AQUEOUS SYSTEMS. F.J.Radd and L.H.Crowder
Nature (London), Vol. 184, 443-4 (Aug. 8, 1959).

Tensile test pieces prepared from a thin sheet of paraffin wax were immersed in either water or a detergent solution and slowly stressed. With the detergent molecules present there were many surface cracks, and the elongation was much less than in distilled water. The elongation impairment was in direct relation to the observed wetting action. R.Schnurmann

539.4

3159 INTERNAL RUPTURE OF BONDED RUBBER CYLINDERS IN TENSION. A.N.Gent and P.B.Lindley.
Proc. Roy. Soc. A, Vol. 249, 195-205 (Jan. 1, 1959).

An unusual rupture process is described. It consists of the sudden appearance of internal cracks in bonded rubber cylinders at a well-defined and comparatively small tensile load. The cracks occur in all the vulcanizates examined, and in particularly weak rubbers are found to cause failure. Their appearance may also lead to marked changes in the load-deflection relationship. A theoretical treatment is presented on the basis of a proposed criterion for crack formation. It is assumed that they form when the negative hydrostatic pressure component of the applied stress reaches a critical value. It is shown by means of the theory of large elastic deformations that a critical value of the negative pressure exists at which any cavity in the rubber will burst, and the calculated value is shown to be in satisfactory agreement with experiment. Moreover, the theory successfully predicts the observed dependence of the cracking stress on the Young's modulus of the rubber, its virtual independence of the rubber strength and extensibility, and the general form of the observed variation of cracking stress and crack disposition with the thickness of the test-piece.

539.5 : 539.219

BRITTLENESS OF COBALT-IRON ALLOYS. See Abstr. 3271

539.5

3160 STRESS RELAXATION IN ELASTOMERS BY VISCO-ELASTIC MECHANISMS. I. NATURAL RUBBER AT HIGH RATES OF STRAIN AND LOW TEMPERATURES.
G.Allen, G.Gee and B.E.Read.
Trans Faraday Soc., Vol. 55, Pt 9, 1651-9 (Sept., 1959).

The influence of rate of strain, extension ratio and temperature on the relaxation curves of 7 natural rubber compounds is reported. All compounds showed linear visco-elastic behaviour at low extension ratios and the relaxation curves showed only minor variations which could be attributed to the vulcanization recipe. The onset of visco-elasticity is attributed to effects arising mainly from chain stiffening.

539.5 : 532.5

3161 COMPARISON OF FLOW LINES IN VARIOUS TYPES OF RHEOLOGICAL BODIES. S.C.Das.
Canad. J. Phys., Vol. 38, No. 1, 32-7 (Jan., 1960).

An attempt has been made to investigate the nature of flow in Bingham bodies compressed by means of parallel rigid approaching plates. The results have been compared with those of plastic and viscous flow under the same conditions. It is shown that the flow lines in all three cases are very similar.

539.6

3162 INVESTIGATION OF DIFFUSION PROCESSES IN THE ADHESION OF POLYMERS BY LUMINESCENT METHOD. N.A.Krotova and L.P.Morozova.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 141-4 (July 1, 1959).
In Russian.

Tropaeolin was used as a phosphor (concentration 1/20 000) in the solvent of one of the two polymers used in each experiment (the following pairs were tested: gelatin/polyvinyl alcohol, perchlorvinyl/guttapercha, guttapercha/paraffin wax and crude rubber/crude rubber). The luminescent analysis disclosed the nature of the boundary (sharp or diffuse) and the location of the rupture produced on tearing (whether along the boundary or within one of the polymers), whereas the signs of electric charges produced in some pairs on rupture were determined by means of a valve electrometer.
F.Lachman

539.6

3163 THEORY OF COHESIVE PEELING OF ADHESIVE JOINTS. F S.C.Chang.
J. appl. Phys., Vol. 30, No. 11, 1839-41 (Nov., 1959).

A theory is developed of the symmetrical separation, by peeling off from one end, of two strips joined by an adhesive. A steady state is considered and a differential equation is obtained for the lateral displacement of each strip as a function of distance, in the region where strings of adhesive are formed, a constant flexural rigidity being assumed for the solid strips. A series solution for the displacement is obtained when the rheological properties of the adhesive are represented by a three-constant linear viscoelastic solid model.
J.G.Oldroyd

539.6

3164 A THEORY OF THE ABRASION OF SOLIDS SUCH AS METALS. J.Goddard, H.J.Harker and H.Wilman.
Nature (London), Vol. 184, 333-5 (Aug. 1, 1959).

Blocks of Cu, Ag, Pt, Al, Fe, Mo and W were slid under normal loads up to 2 kg. at about 5 cm/sec on emery papers having mean particle diameters 5 to 150 microns. A linear relation holds, for each metal, between the amount of wear per unit distance per unit load and the coefficient of friction. A theory is developed, which accounts well for these results, on the basis that the deformation of the metal is mainly plastic.
J.G.Oldroyd

539.62

3165 LOW FRICTION OF METALS IN RECIPROCATING SLIDING. Y.Tamai.
J. appl. Phys., Vol. 30, No. 12, 1874-5 (Dec., 1959).

A very low friction, ~ 10^{-3}, was unexpectedly observed in reciprocating sliding with gold, silver, copper and platinum. The characteristics common to these metals were soft metal substrates and no surface oxide or soft oxide. The phenomenon is discussed.

539.6

3166 REVIVING THE CLASSICAL THEORY OF FRICTION BY A MODERN DISLOCATION THEORY OF DEFORMATION REVISION. J.H.Dismant.
J. appl. Phys., Vol.31, No.1, 221-2 (Jan., 1960)

Ammonton's (1699) classical theory of friction, modified to the extent that surface asperities deform elastically or plastically as they slide over each other instead of remaining rigid, accounts for all major frictional phenomena. The effect of a boundary lubricant is to restrict the generation and motion of dislocations, so increasing yield strengths of crystalline asperities. Experimental support comes from measurement of yield points of very fine Cu wire springs, which show up to 45 per cent average increase after dipping in oleic acid solution.
J.G.Oldroyd

539.8 : 669

3167 THE DIFFUSION THEORY OF SINTERING. V.A.Ivensen.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 2, 370-5 (1958).
In Russian.

The theory of the mechanism of compaction on sintering put forward by Pines [Zh. tekh. Fiz., Vol. 23, 2078(1953)] is criticized as being inadequate. Frenkel's theory which treats a non-uniform distribution of vacancies supplemented by a representation of the generation of vacancies in the process of re-formation is thought to be more realistic.
A.L.Mackay

539.8 : 669

3168 MORE ON THE THEORIES OF SINTERING. B.Ya.Pines.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 2, 375-81 (1958).
In Russian.

It is shown that, in spite of Ivensen's assertions (see preceding abstract), the diffusion mechanism of sintering is fully valid even in the stage of inter-communicating pores. It is claimed that Frenkel's theory has been misunderstood and Pines' diffusion theory is a development from Frenkel's, which is the only extant theory.
A.L.Mackay

CRYSTALLOGRAPHY
CRYSTAL STRUCTURES

539.2 : 548.

3169 THE DIAMOND. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 44, No. 3, 99-110 (Sept., 1956).

A general account of crystal properties.

539.2 : 548

3170 LOW-TEMPERATURE POLYMORPHISM OF METALS. I.A.Gindin, B.G.Lazarev, Ya.D.Starodubov and V.I.Khotkevich.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 802-4 (Sept., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 3, 556-7 (March, 1959).

The low-temperature allotropic transformations produced by plastic deformation of Li, Na, Cs, Bi and Be are studied by tracing the compression diagrams at various temperatures and by recording the changes in volume due to the reverse transformation during heating. Characteristic discontinuities are observed in the deformation curves, corresponding to a drop in the resistance to deformation when a considerable portion of the metal has changed structure. The heating curves give directly the absolute change of length of the specimen in the process of transformation.
L.Pincherle

539.2 : 548

3171 A STUDY OF THE ALLOTROPIC TRANSFORMATION OF CsCl BY MEASURING THE SPEED OF RELEASE OF S^{35} PRODUCED BY NEUTRON IRRADIATION.
F.Lanteime and J.Pauly.
C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 677-9 (Aug. 3, 1959).
In French.

Caesium chloride crystals were irradiated by slow neutrons and the S^{35} produced was separated off by heating in hydrogen. The change in the rate of S^{35} evolution at 480° C indicates a change in the allotropic form of CsCl at that temperature.
A.E.I. Research Laboratory

539.2 : 548

3172 DISLOCATION ARRAYS IN DEPTH AND RECRYSTALLIZATION PRODUCED BY SURFACE DEFORMATION OF SINGLE CRYSTALS OF COPPER AT HIGH TEMPERATURE.

J.M.Bailey and A.T.Gwathmey.
J. appl. Phys., Vol. 31, No. 1, 215-17 (Jan., 1960).

Surface deformation was effected at various temperatures by sliding sapphire styli across the (111) faces. Etching produced pits at clean dislocations intersecting the surface. Deformation at temperatures above 250°C produced recrystallization, and above 500-600°C polygonization was observed. Electropolishing revealed the change in dislocation distributions with depth below the surface: recrystallization penetrated 25-50μ and plastic deformation 150μ.

R.C.Kell

539.2 : 548.5

3173 ON THE MECHANISM OF THE INFLUENCE OF ALUMINIUM ON THE CRYSTALLIZATION OF IRON. D.S.Kamenetskaya, E.P.Rakhmanova, E.Z.Spektor and V.I.Shiryaev.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 5, 924-7 (Oct. 11, 1959).
In Russian.

The efficiency of additions of aluminium in promoting crystallization in melts of iron was estimated by measuring the degree of supercooling which could be obtained in such melts. For pure iron the supercooling was ~ 200° C which decreased to less than 10° if 0.03% aluminium was added. If 0.3% Fe_2O_3 was added, as well as the aluminium, the supercooling returned to the former value of ~200°C.

A.L.Mackay

539.2 : 548.5

3174 EXTENSION OF A SIMPLE METHOD FOR CRYSTAL GROWTH. A.Ascoli, M.U.Odescalchi and G.M.Schiavini.
Energia nucleare, Vol. 6, No. 12, 781-3 (Dec., 1959).

Successful results are obtained in growing β-tin, zinc, silver, gold and copper single crystals by a simple method previously described [Energia nucleare, Vol. 5, No. 9, 591 (Sept., 1958)], as useful in the case of lead. The difficulties encountered in growing tin single crystals are overcome by slightly modifying the form of the crucible.

539.2 : 548.5

3175 GROWTH OF InSb CRYSTALS IN THE [111] POLAR DIRECTION. H.C.Gatos, P.L.Moody and M.C.Lavine.
J. appl. Phys., Vol. 31, No. 1, 212-13 (Jan., 1960).

When the end of the [111] seed crystal terminating in Sb atoms was used, single crystals were invariably obtained. Growth on the end of the seed terminating in In atoms frequently produced twinning or large grain formation. An atomic model accounts for the differences in behaviour of the two surfaces during etching or crystal growth.

R.C.Kell

539.2 : 548.5

3176 NUCLEATION OF ALUMINA AT HIGH SUPERSATURATIONS AND SUBSEQUENT RECRYSTALLIZATION. G.W.Sears and R.C.DeVries.
J. chem. Phys., Vol. 32, No. 1, 93-5 (Jan., 1960).

Previous studies of the growth of alumina crystals have demonstrated the validity of current crystal growth theory for a high-temperature system involving a chemical reaction. The nucleation of alumina on a perfect alumina surface has been studied in the present report at very high supersaturations. The nucleation event is not consistent with the classical theory of nucleation, but rather is described by the Cahn–Hilliard theory of nucleation based on their treatment of the thermodynamics of nonuniform systems. In addition, the recrystallization of polycrystalline deposits to give near perfect crystal was observed.

539.2 : 548.5

3177 THE GROWTH OF OXIDE SINGLE CRYSTALS CONTAINING TRANSITION METAL IONS. F.W.Harrison.
Research, Vol. 12, No. 10-11, 395-403 (Oct.-Nov., 1959).

Problems discussed include high melting point and reactivity, and dissociation with evolution of oxygen below the melting point. Methods are described which overcome some or all of these difficulties, the more important being the flame fusion process, the Bridgman–Stockbarger and the lead oxide solution methods.

539.2 : 548.5

3178 ARC-IMAGE FURNACE FOR GROWTH OF SINGLE CRYSTALS. R.E. De La Rue and F.A.Halden.
Rev. sci. Instrum., Vol. 31, No. 1, 35-8 (Jan., 1960).

A carbon arc-image furnace has been designed and employed for the growth of single crystals of refractory compounds. The image furnace is a unique facility for this application since it provides a sharply defined hot zone, excellent atmosphere control, and complete freedom from contamination during crystal growth. General operating and performance characteristics of this furnace are described.

539.2 : 548.5

3179 GROWTH OF TOBACCO MOSAIC VIRUS PARTICLES. G.W.Sears.
Science, Vol. 130, 1477-8 (Nov. 17, 1959).

Past studies have characterized the structure of tobacco mosaic virus particles by a variety of methods. In the present report the screw dislocation theory of crystal growth is applied to the formation of tobacco mosaic virus particles. The growth mechanism is shown to account for the rodlike morphology. It is also deduced that the biosynthetic process occurs at the growth step at the end of a particle.

539.2 : 548.5

3180 X-RAY STUDY ON SPHERULITIC CRYSTALLINE AGGREGATES OF STRONTIUM SULFATE FORMED IN THE SOLUTION CONTAINING SODIUM TRIPHOSPHATE. Y.Takano and S.Otani.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 109-12 (April, 1959).

Spherulitic crystalline aggregates of strontium sulphate formed in the solution containing sodium triphosphate were examined through the method of micro-focus X-ray and microphotography. When the spherulite is formed in the solution containing sodium triphosphate, an aggregate of many minute crystallites appears first, and then only crystallites which have the proper orientation for their growth along the C axis begin their growth; and, at the same time, many nuclei begin to appear upon their surfaces, each nucleus also beginning growth separately. In this way a spherical aggregate is finally formed.

539.2 : 548.5

3181 ON GRAPHITE WHISKERS. P.J.Bryant, T.B.Daniel and F.R.Rollins,Jr.
J. appl. Phys., Vol. 30, No. 11, 1839 (Nov., 1959).

Whiskers grown in a boule [Bacon and Bowman, Bulletin of The American Physical Society, Ser. II, Vol 2, 131, (1957)] were removed by heating to 525° C for 2 min in a stream of oxygen.

J.E.Caffyn

539.2 : 548.5

3182 AN OBSERVATION OF PAIRED SCREW DISLOCATIONS IN IRON WHISKERS. E.W.Müller.
J. appl. Phys., Vol. 30, No. 11, 1843-4 (Nov., 1959).

The tips of iron whiskers were observed in a high-resolution field ion microscope. In several whiskers with a [001] axis there was a pair of dislocations 100 A apart and near the whisker axis; the screw components of the Burgers vectors of these dislocations were in the whisker axis and of opposite sign. It is possible that paired axial screw dislocations always occur in whiskers without the Eshelby twist.

B.T.M.Willis

539.2 : 548.5

3183 GROWTH OF ALUMINUM OXIDE WHISKERS BY VAPOR DEPOSITION. R.C.DeVries and G.W.Sears.
J. chem. Phys., Vol. 31, No. 5, 1256-7 (Nov., 1959).

The growth of aluminium oxide crystals was observed in progress at 80× magnification with a stereo-microscope. Hydrogen is passed over an aluminium-oxide rod heated by a surrounding tungsten coil. As the hot products diffuse to the cooler region around the reaction zone, the reaction reverses to grow aluminium oxide crystals. This system is of particular interest since it allows the screw dislocation theory of crystal growth to be examined in great detail on a high-temperature system.

539.2 : 548.5

3184 GROWTH OF WHISKERS BY REDUCTION OF HALOGENIDES. H.Wiedersich.
J. Electrochem. Soc., Vol. 106, No. 9, 810-15 (Sept., 1959).

By reduction of $SiCl_4$ with Zn, silicon was produced and similarly Fe by reduction of $FeCl_2$ with H_2. In both cases variations of the growth conditions changed the forms of the crystals from equiaxed into thin, long ones (whiskers). Thermodynamic and kinetic considerations lead to the conclusion that the partial pressure of $SiCl_4$, $FeCl_2$ or HCl determine the growth forms. The hypothesis is suggested that the adsorption of these components makes certain crystallographic plane growth inactive and therefore produces whisker growth.

539.2 : 548.5

3185 TECHNIQUES FOR HANDLING METALLIC WHISKERS. E.L.Fontanella and R.W.DeBlois.
Rev. sci. Instrum., Vol. 30, No. 11, 982-3 (Nov., 1959).

Detailed descriptive methods are presented for the selection, removal, and preparation for experimental use of both iron and copper whiskers. Techniques which minimize damage are emphasized.

539.2 : 548.5

3186 RELATION BETWEEN OPTICAL ORIENTATION ACCURACY AND ETCH TIME.
P.L.Ostapkovich and M.Ranaldi.
J. appl. Phys., Vol. 30, No. 12, 2019 (Dec., 1959).

The etching procedure used in the optical determination of the orientation of germanium is reviewed. It is claimed that by using as short an etching time as possible the accuracy of orientation is better than $\frac{1}{4}°$. B.T.M.Willis

539.2 : 548.5

3187 ETCH PITS ON THE CLEAVAGE SURFACE OF NaCl CRYSTAL. S.Nakagawa.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 85-93 (April, 1959).

When the cleavage surface of NaCl crystal is etched in saturated $MnCl_2 \cdot 4H_2O$ aqueous solution, the etch pits generated on the whole-cleavage surface have particular types of patterns and the farther away from the tapped point of the cleavage chisel they are deeper is their depth up to the time of their disappearance. The pits patterns present themselves symmetrically on the matching cloven pieces, especially with regard to the grouping of etch pits found near the edge of crystal opposite to the tapped point. As etching goes on, all the etch pits belonging to this latter group develop to some extent perpendicularly to the (100) cleavage plane and finally disappear. The depth of each etch pit up to the time of their disappearance is nearly the same, so far as the same plane is concerned, but when the matching cloven pieces are compared, it is considerably different in every case.

539.2 : 548.5

3188 CLEAVAGE FRACTURE OF NaCl CRYSTAL. T.Fujiwara, S.Nakagawa and K.Izui.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 95-108 (April, 1959).

The behaviour of the cleavage surfaces of NaCl crystals were studied through electronmicroscopical observations. The experiment succeeded in matching together both cleaved surfaces. On the flat cleavage surfaces, protuberances of various shapes as well as torn-off fractures were found. It was seen how both the wide step lines running roughly parallel to the direction of cleavage crack and the steep and zigzag ones running almost at right angles to that direction are generated. On these steps, those parts presenting scooped-out or torn-off fractures or fragmentarily broken fractures were also seen.

539.2 : 548.5

3189 OBSERVATIONS ON THE OXIDATION OF HEAT TREATED (111) SURFACES OF GERMANIUM. L.Gouskov.
C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 671-3 (Aug. 3, 1959). In French.

Oriented corrosion figures were obtained on single crystal germanium surfaces, after electrolytically polishing, heating in vacuum and oxidizing in air at 450° C and a pressure of 10^{-2} mm Hg. J.E.Caffyn

539.2 : 548.7

3190 PERFECT POLARISATION OF X-RAYS BY CRYSTAL REFLECTION. K.S.Chandrasekaran.
Proc. Indian Acad. Sci. A, Vol. 45, No. 6, 387-91 (Dec., 1956).

The performance of an experimental set-up for polarizing X-rays, used to study crystal perfection, is discussed. A value of 0.2 per cent, for the percentage of unpolarized X-rays believed to be the best reported, was obtained, using the 311 reflection (Bragg angle 45° 9') of a copper crystal, with CuKα (λ ≈ 1.542 A) radiation. Theoretically, the perfection of polarization should have been even better, but for a small amount of fluorescent CuKα radiation emitted by the polarizing crystal.

539.2 : 548.7

3191 A CONTRIBUTION TO THE SEMI-FOCUSING METHOD WITH A FLAT POLYCRYSTALLINE SAMPLE. M.Simerská and V.Syneček
Czech. J. Phys., Vol. 9, No. 3, 395-8 (1959).

Conditions are derived for the approximate focusing of diffraction lines in a given, relatively wide, angular region, using a bent-crystal monochromator. The form of the absorption factor for a flat polycrystalline sample is derived for the case of uniform oscillation of the sample in the angular region $\pm \epsilon$ around the axis of the camera.

539.2 : 548.7

3192 A SMALL FURNACE FOR USE WITH SEIFERT X-RAY DIFFRACTOMETER. P.D.Pathak and N.V.Pandya.
Curr. Sci., Vol. 28, No. 8, 320-1 (Aug., 1959).

Describes a small and easily constructed furnace, working up to 800°C, for use with a flat powder specimen and focusing diffractometer. A.R.Stokes

539.2 : 548.7

3193 X-RAY DIFFRACTOMETRY WITH SLIGHTLY ABSORBING SAMPLES.
H.A.Levy, P.A.Agron and M.D.Danford.
J. appl. Phys., Vol. 30, No. 12, 2012-13 (Dec., 1959).

The absorption correction for symmetrical reflection from a crystal surface is made more reliable by use of a modified system of slits before the detector. A.R.Stokes

539.2 : 548.7

3194 DOUBLE CRYSTAL X-RAY MONOCHROMATOR-COLLIMATOR. R.S.Williamson and I.Fankuchen.
Rev. sci. Instrum., Vol. 30, No. 10, 908-10 (Oct., 1959).

A pair of crystals mounted so as to have perpendicular planes of incidence is used to produce a collimated monochromatic X-ray beam. The design permits simple adjustment of the final beam inclination.

539.2 : 548.7

3195 NEW DEVICE FOR OBTAINING X-RAY DIFFRACTION PATTERNS FROM SUBSTANCES EXPOSED TO HIGH PRESSURE. J.C.Jamieson, A.W.Lawson and N.D.Nachtrieb.
Rev. sci. Instrum., Vol. 30, No. 11, 1016-19 (Nov., 1959).

A device is described for obtaining powder diffraction patterns of thin sheets pressed between opposing diamond pistons. The pressure, initially applied by a small auxiliary laboratory press, is clamped onto the sample by a lock-nut. The whole unit is designed to replace the sample mount of a standard X-ray diffraction unit. Sample patterns taken on two of the high pressure modifications of bismuth are exhibited.

539.2 : 548.7

3196 AUTOMATIC CONTROL AND PROGRAMING SYSTEM FOR SINGLE CRYSTAL DIFFRACTOMETRY. F.Langdon and B.C.Frazer.
Rev. sci. Instrum., Vol. 30, No. 11, 997-1003 (Nov., 1959).

An automatic control and programming system for the collection of single crystal diffraction data is described. The system has been designed for a neutron diffractometer, but it could easily be adapted for use with X-rays.

539.2 : 548.7

3197 A COMBINATION OF X-RAY PRECESSION CAMERA WITH TWO-CIRCLE GONIOMETER. Chang Yuan-Lung.
Science Record (China), New Series, Vol. 3, No. 6, 258-62 (June, 1959).

Describes a precession camera of the Buerger type with the precession motion produced by two oscillatory motions with a phase difference of 90°. A.R.Stokes

539.2 : 548.7 : 537.311

3198 MEASUREMENT OF THE INTENSITY OF X-RAY DIFFRACTION PATTERNS WITH THE AID OF A GaAs BARRIER LAYER CELL. H.Pfister.
Z. angew. Phys., Vol. 11, No. 8, 290-6 (Aug., 1959). In German.

The use of a semiconducting barrier layer as an X-ray detector is discussed. The short circuit current is independent of temperature but measurement of the open circuit voltage offers higher sensitivity. The application of a GaAs barrier layer cell in place of a Geiger counter in an X-ray powder diffraction apparatus is considered in some detail. T.Mulvey

539.2 : 548.7

3199 NEUTRON DIFFRACTION INSTRUMENTS AT A HIGH-FLUX NUCLEAR REACTOR.

G.E.Bacon and R.F.Dyer.
J. sci. Instrum., Vol. 36, No. 10, 419-21 (Oct., 1959)

A large instrument for use with polycrystalline sample is described, and another, much smaller, for single-crystal work. An account is included of the associated in-pile equipment and shielding for producing the collimated beams of thermal neutrons.

539.2 : 548.7

3200 A GENERAL METHOD FOR DETERMINING FILM-TO-FILM SCALING CONSTANTS. R.E.Dickerson.
Acta cryst., Vol. 12, Pt 8, 610-11 (Aug., 1959).

Intensities of spots on a set of precession photographs are scaled in such a way as to minimize the sum of $(J_{ij}-J_{ji})^2$, where J_{ij} is the sum, after scaling, of all intensities of reflections on the i^{th} film that also appear on the j^{th} film. This procedure is compared with that of Kraut [Acta cryst., Vol. 11, Pt 12, 895, (Dec., 1958)], which tends to over-emphasize the effect of low-intensity spots. A.R.Stokes

539.2 : 548.7

3201 A STUDY OF THE INFLUENCE OF THE ASYMMETRY OF THE $K\alpha_1$ X-RAY EMISSION LINE OF COBALT AND COPPER ON ACCURATE MEASUREMENTS OF LATTICE PARAMETERS. A.Kochanovská.
Czech. J. Phys., Vol. 9, No. 3, 348-60 (1959).

From accurate measurements of the lattice parameters of aluminium, silver and gold by $K\alpha_1$ radiation of copper and cobalt, it is proved that the values determined by the radiation of cobalt are systematically lower than those determined by the radiation of copper. A semi-quantitative analysis of the influence of spectral asymmetry on the determination of the parameter from X-ray diffraction lines is carried out and it is proved that this influence is defined not only by the index of asymmetry of the emission line but also by the broadening of the corresponding diffraction line. From this analysis it follows that the differences in the parameter measured, when using radiation of cobalt and copper, can be explained by the influence of the spectral asymmetry of the emission lines $K\alpha_1$ of these radiations.

539.2 : 548.7

3202 THE INFLUENCE OF THE SPECTRAL ASYMMETRY OF X-RAY EMISSION LINES ON THE RESULTS OF STUDYING DEFECTS IN CRYSTALS BY X-RAYS OF DIFFERENT WAVELENGTH. A.Kochanovská.
Czech. J. Phys., Vol. 9, No. 3, 361-6 (1959).

Since the asymmetry of X-ray emission lines has been found to influence the exact measurements of lattice parameters of powdered samples (see preceding abstract), the author has revised the results presented in Czech. J. Phys., Vol. 7, No. 2, 124-88 (1959). It is shown that with samples having an inhomogeneous distribution of the admixtures in the crystals the typical graphs of lattice parameter found originally remain when taking account of the influence of the spectral asymmetry. On the other hand, with a sintered sample, which has been homogenized by long annealing, the introduction of corrections to spectral asymmetry leads to an adjustment of the differences measured originally, for which it was difficult to find a probable explanation.

539.2 : 548.7

3203 NEUTRON PROPAGATION IN PERFECT CRYSTALS OF FINITE SIZES. A.Herpin.
J. Phys. Radium, Vol. 18, No. 12, 649-55 (Dec., 1957). In French.

The dynamical theory of neutron propagation in a perfect crystal is given. For X-rays this theory departs from electromagnetic laws, but for neutrons, the starting point is the neutron–nucleus interaction, considered as a point. Refraction indices are deduced for all waves which are allowed to propagate close to a Bragg reflection. The influence of thermal motion has been taken into account.

539.2 : 548.7

3204 SCATTERING OF ELECTRONS BY THERMAL MOTION OF ATOMS IN A CRYSTAL. A.Laberrigue.
Ann. Phys. (Paris), Ser. 13, Vol. 4, No. 3-4, 385-433 (March-April, 1959). In French.

The intensities of some Bragg electron diffraction spots produced by an Al single crystal at 20°, 230° and 320°C, decreased with increasing temperature proportionally to the Debye factor. The variation of intensity with temperature at high and low angles of scattering is discussed. J.Franks

539.2 : 548.7

3205 DETERMINATION OF CRYSTALLINE POTENTIAL WITH THE AID OF FINE STRUCTURE IN ELECTRON DIFFRACTION. Y. Le Corre.
Cahiers de Phys., Vol. 12, 41-7 (Feb., 1958). In French.

The author briefly reviews various methods of using electron diffraction to obtain an absolute measurement of the components of the potential in a crystal. At present the method can only be used with very thin crystals. It is pointed out that electron diffraction has many advantages over X-ray diffraction in such studies.
A.E.I. Research Laboratory

539.2 : 548.7

3206 OPERATORS FOR ELECTRON DIFFRACTION BY A CRYSTAL LATTICE. H.Niehrs.
Z. Phys., Vol.156, No.3, 446-67 (1959). In German.

The behaviour of electron waves at boundaries in a crystal is discussed and boundary conditions introduced enabling the various reflection and refraction processes to be described analogously to the optical treatment of bounded homogeneous media. A matrix operator can be assigned to each process, describing the transformation of amplitude distributions in possible ray directions in vacuum and in the crystal. J.Franks

539.2 : 548.7

3207 QUANTITATIVE TREATMENT OF MULTIPLE SCATTERING EFFECT IN CONTINUOUS ELECTRON DIFFRACTION CURVES. J.Gjønnes.
Acta cryst., Vol. 12, Pt 12, 976-80 (Dec., 1959).

The theory of noncoherent multiple scattering is reviewed and calculation procedures are derived which permit the conversion of an experimental intensity distribution given in a limited angular region and corresponding to a thickness t into (a) the intensity distribution corresponding to a thickness nt, (b) the single scattering cross-section. The background and oscillating terms are treated separately. The methods are applied to diffractograms obtained from evaporated carbon films in the thickness range 100-600 A using an accelerating voltage of 36 kV.

539.2 : 548.7

3208 ABSORPTION AND PATH OF INTERFERING X-RAY BEAMS IN A WEAKLY DEFORMED CRYSTAL LATTICE. G.Borrmann and G.Hildebrandt.
Z. Phys., Vol.156, No.3, 189-99 (1959). In German.

A narrow X-ray beam was passed through a thick calcite crystal, so as to produce Bragg-reflected and transmitted beams. The crystal was slightly distorted by maintaining a temperature difference up to 0.6°C between its faces, and the variations of reflected and transmitted intensities with temperature differences were recorded; both show a large decrease. A.R.Stokes

539.2 : 548.7

3209 A STUDY OF INITIAL DEFORMATION OF ALUMINIUM SINGLE CRYSTAL PLATES BY X-RAY DIFFRACTION TECHNIQUE. I. M.Sumizawa and T.Kino.
J. Sci. Hiroshima Univ. A, Vol. 23, No. 1, 57-63 (April, 1959).

The change of lattice distortion in aluminium single crystal plates at the initial stage of tensile deformation was studied by X-ray diffraction methods. The decrease of the integrated intensities of reflected X-rays at the range of transition from the elastic deformation to the plastic one was clearly found, and this phenomenon was discussed qualitatively. In addition, the perfectness of the aluminium single crystal prepared by Fujiwara's method was estimated.

539.2 : 548.7

3210 ELECTRON INTERFERENCE IN SUPERIMPOSED CRYSTAL LAYERS. II. RELATION BETWEEN MULTIPLE REFLECTION AND THE CRYSTAL MOIRÉ. J.Stabenow.
Z. Phys., Vol.156, No.3, 503-21 (1959). In German.

The possibility of using crystal moiré patterns to show structures of undistorted or distorted crystals is considered, and a number of moiré photographs of MoS_2 and Au crystal layers are reproduced. A.R.Stokes

539.2 : 548.7

3211 REGRESSION FORMULAE AND THE JOINT DISTRIBUTION OF STRUCTURE FACTORS. P.A.Vaughan.
Acta cryst., Vol. 12, Pt 12, 981-7 (Dec., 1959).

The joint distribution (frequency) function of a set of structure factors can be obtained as an expansion in terms of a general set of orthogonal polynomials. The series given by Hauptman and Karle (1953) and also by Bertaut (1955) is a particular example of such an expansion. The question is considered from the standpoint of regression formulae and it is shown that the (terminated) sign-determining series of Hauptman and Karle does not represent a least-squares regression formula. A method of obtaining improved regression formulae is considered and illustrated in the case of space group PI. A numerical example is presented for a synthetic structure.

539.2 : 548.7

3212 THE DISTRIBUTION OF PHASE ANGLES FOR STRUCTURES CONTAINING HEAVY ATOMS. II. A MODIFICATION OF THE NORMAL HEAVY-ATOM METHOD FOR NON-CENTROSYMMETRICAL STRUCTURES. G.A.Sim.
Acta cryst., Vol. 12, Pt 10, 813-15 (Oct.,1959).

Woolfson's method of weighted Fourier synthesis (Abstr. 7628 of 1959) for a centrosymmetrical structure is modified for a non-centrosymmetrical structure, by applying the probability distribution of phase angles. A.R.Stokes

539.2 : 548.7

3213 RANDOMISED AND PSEUDORANDOMISED SUBSTANTIALIZATION OF SIGN SEQUENCES. I.J.Good.
Acta cryst., Vol.12, Pt 10, 824-5 (Oct., 1959).

Sets of sign combinations of structure factors for trial Fourier syntheses of crystal structures may be generated in a pseudo-random order (i.e. an order which appears random but is in fact generated according to a pre-arranged system) by a method which is described. This method of trial is likely to lead to a near-correct solution after a fairly small number of attempts. A.R.Stokes

539.2 : 548.7

3214 SYNTHESES FOR THE DECONVOLUTION OF THE PATTERSON FUNCTIONS. I. GENERAL PRINCIPLES. G.N.Ramachandran and S.Raman.
Acta cryst., Vol. 12, Pt 12, 957-64 (Dec., 1959).

The paper deals with a series of Fourier syntheses which have been worked out for "developing" a structure when information is available about a part of the structure, i.e. when some of the atomic positions are known. The syntheses are of two classes, which have been named the alpha and beta classes. In the former class, a suitable combination of the measured intensities, namely $|F(H)|^2$, with the intensities due to the known group of atoms alone, say $|Fp(H)|^2$, is multiplied by $Fp(H)$, the structure factor of the known atoms, and these are used as coefficients in a Fourier syntheses. In the beta class, the same combination is divided by $F_p^*(H)$ and then used as coefficients in the Fourier synthesis. In both classes of syntheses, there is a concentration of electron density at the positions of the unknown atoms. In each class, four different types of syntheses have been suggested according to the nature of the available data, e.g., if only a single crystal is available, or if an isomorphous pair is available, or if some atoms in the single crystal exhibit anomalous dispersion and so on. The unwanted background is least in the case of isomorphous and anomalous syntheses, of which the latter is the more powerful one. The syntheses are particularly useful with non-centrosymmetric crystals, although, if the known group of atoms have a centre of symmetry, then the syntheses also exhibit an artificial inversion centre.

539.2 : 548.7

3215 SYNTHESES FOR THE DECONVOLUTION OF THE PATTERSON FUNCTION. II. DETAILED THEORY FOR NON-CENTROSYMMETRIC CRYSTALS. S.Raman.
Acta cryst., Vol. 12, Pt 12, 964-75 (Dec., 1959).

This part contains the more detailed mathematical portion of theory discussed in Pt 1. First, the significance of various syntheses using as coefficients F, $|F|^2$, F^2, $|F|$, $\exp[i\alpha]$, $\exp[2i\alpha]$, $1/F$, $|F|\exp[i(\pi-\alpha)]$ and also products of the type F_1F_2, where F_1 and F_2 are the structure amplitudes of two portions of a structure, is discussed. It is then used to work out the positions and strengths of the peaks in the different types of alpha and beta syntheses. The new syntheses are also compared with the known types of syntheses, such as the "heavy atom-phased syntheses". The main theoretical results have been verified by detailed numerical computation made with a hypothetical non-centric structure containing 6 atoms.

539.2 : 548.7

3216 ON THE ISOTROPIC TEMPERATURE FACTOR EQUIVALENT TO A GIVEN ANISOTROPIC TEMPERATURE FACTOR. W.C.Hamilton.
Acta cryst., Vol. 12, Pt 8, 609-10 (Aug., 1959).

It is shown how an isotropic temperature factor may be obtained, such that the mean squared displacement of atoms is the same as for the given anisotropic factor. Applications to crystal structure refinement are suggested. A.R.Stokes

539.2 : 548.7

3217 CALCULATION OF ORDER PARAMETERS IN A BINARY ALLOY BY THE MONTE CARLO METHOD. L.D.Fosdick.
Phys. Rev., Vol. 116, No. 3, 565-73 (Nov. 1, 1959).

A Monte Carlo sampling scheme similar to that used by Metropolis, Wood, and others in equations of state computations for gases was used to investigate order–disorder phenomena in a face-centred cubic A_3B alloy. The model of the alloy assumes that the structure of the lattice is fixed and that interactions exist between first neighbours and second neighbours only. In most of the calculations detailed consideration is given to an array consisting of five unit cells on an edge (500 sites) with periodic boundary conditions. The long-range order and short-range order for first and second neighbours was computed above and below the critical temperature. Using the energy parameter,

$$v_n = [(V_{AA}(r_n) + V_{BB}(r_n))/2] - V_{AB}(r_n)$$

for nth neighbours it is found that $v_2/v_1 = 0.25$ and $v_1 = 816$ cal/mole gives the best agreement with experiments on Cu_3Au. The critical temperature appears to vary linearly with the ratio v_2/v_1.

539.2 : 548.7

3218 A GRAPHICAL AID FOR CALCULATING STRUCTURE FACTORS. L.Cavalca and M.Nardelli.
Acta cryst., Vol. 12, Pt 9, 701 (Sept., 1959).

A simple graphical method is described for evaluating products of the form

$$\begin{matrix}\cos\\ \sin\end{matrix}(2\pi hx)\,.\,\begin{matrix}\cos\\ \sin\end{matrix}(2\pi ky).$$

R.F.S.Hearmon

539.2 : 548.7

3219 ON THE CRYSTAL CHEMISTRY OF NORMAL VALENCE COMPOUNDS. E.Mooser and W.B.Pearson.
Acta cryst., Vol. 12, Pt 12, 1015-22 (Dec., 1959).

A new classification of the crystal structures of normal valence compounds with simple atomic ratios is discussed. This classification is based on two atomic parameters which gauge the directional properties of the bonds in a compound. The parameters are (1) the average principal quantum number, $\bar{n}$, of the valence shell of the component atoms and (2) the difference, Δx, between the electronegativities of anion and cation. It is shown that the most common structures of compounds of composition A_iX_j (i, j = 1, 2, 3) occur only in certain well defined regions of a $\bar{n}$ versus Δx diagram, and the proposed classification, therefore, is of considerable help in understanding and predicting the structures of normal valence compounds.

539.2 : 548.7

3220 CRYSTAL STRUCTURE OF β-Hg. M.Atoji, J.E.Schirber and C.A.Swenson.
J. chem. Phys., Vol. 31, No. 6, 1628-9 (Dec., 1959).

The crystal structure of β-Hg, a pressure-induced modification of mercury which is the stable form below 79° K, was determined. Whereas ordinary (α) mercury crystallizes in a simple rhombohedral lattice, β-Hg is found to be a body-centred tetragonal with $a = 3.995$ A, and $b = 2.825$ A at 77° K. Both phases are superconductors. A brief description of the low-temperature X-ray cryostat and camera is given. The relation of α-Hg and β-Hg to Pauling's resonating valence bond theory of metals is discussed.

539.2 : 548.7

3221 A NEW INTERMEDIATE PHASE IN THE NIOBIUM-ALUMINIUM SYSTEM. C.R.McKinsey and G.M.Faulring.
Acta cryst., Vol. 12, Pt 9, 701-2 (Sept., 1959).

Nb-Al alloys were prepared by arc melting. X-ray examination showed the existence of a new phase Nb_2Al. It is tetragonal with $a = 9.943$ A, $c = 5.186$ A, calculated density (assuming 30 atoms per unit cell) 6.85 g cm^{-3}, observed density 6.87 g cm^{-3}. R.F.S.Hearmon

539.2 : 548.7

3222 THE CRYSTAL STRUCTURE OF PuNi.
D.T.Cromer and R.B.Roof, Jr.
Acta cryst., Vol. 12, No. 11, 942-3 (Nov., 1959).

539.2 : 548.7

3223 THE CRYSTAL STRUCTURE OF Zr_5Al_3.
C.G.Wilson.
Acta cryst., Vol. 12, No. 11, 947-8 (Nov., 1959).

539.2 : 548.7

3224 A NEW INTERPRETATION OF THE X-RAY DIFFRACTION PATTERN OF MALLINCKRODT UO_3.
D.E.Connolly.
Acta cryst. Vol. 12, No. 11, 949-51 (Nov., 1959).

539.2 : 548.7

3225 THE CRYSTAL STRUCTURE OF ZrO_2 AND HfO_2.
J.Adam and M.D.Rogers.
Acta cryst., Vol. 12, No. 11, 951 (Nov., 1959).

539.2 : 548.7

3226 THE STRUCTURE OF THE INTERMETALLIC PHASE α'(VAl).
P.J.Brown.
Acta cryst., Vol. 12, Pt 12, 995-1002 (Dec., 1959).

The structure of the monoclinic α'-phase in the vanadium—aluminium system was determined and refined. This phase has the ideal composition V_7Al_{45} and is structurally related to both the α and β vanadium—aluminium phases. A description of the structure is given, and the interatomic distances are discussed and compared with those found in the other two phases.

539.2 : 548.7

3227 DIFFRACTION BY PERIODIC ANTIPHASES OF ONE AND TWO DIRECTIONS OF THE $AuCu_3$ TYPE.
P.Perio and M.Tournarie.
Acta cryst., Vol. 12, Pt 12, 1032-8 (Dec., 1959). In French.

A theory is presented describing the diffraction by periodic antiphase structure in ordered $AuCu_3$ type alloys. The treatment is rigorous and allows for non-integer periods. The general shape of the amplitude distribution in any 00l reciprocal plane can be determined without any computation and is given for the six possible configurations of two direction antiphase structures.

539.2 : 548.7

3228 ORDERED STRUCTURE OF AN ALLOY OF COMPOSITION NEAR Au_3Cu.
H.Okuzumi, P.Perio and M.Tournarie.
Acta cryst., Vol. 12, Pt 12, 1039-43 (Dec., 1959). In French.

The structure of an ordered alloy of composition near Au_3Cu is obtained by electron diffraction on the basis of the previous treatment. The satellites around the disordered f.c.c. spots are shown to arise from a density modulation inside each antiphase domain, connected with the departure of the alloy from stoichiometric composition. Previous explanations in terms of lattice modulation or double diffraction are discarded from intensity considerations.

539.2 : 548.7

3229 PERIODIC ANTIPHASES OF ONE DIRECTION IN THE SYSTEM AuCu. P.Perio and M.Tournarie.
Acta cryst., Vol. 12, Pt 12, 1044-7 (Dec., 1959). In French.

The antiphase structure of ordered alloys of the AuCu type was studied. The interpretation presented by earlier workers is shown to be somewhat inadequate and an alternative explanation based upon a composition modulation inside each antiphase domain is put forward.

539.2 : 548.7

3230 CRYSTAL STRUCTURES OF THE ISOSTRUCTURAL MINERALS LAZULITE, SCORZALITE AND BARBOSALITE. M.L.Lindberg and C.L.Christ.
Acta cryst., Vol. 12, Pt 9, 695-7 (Sept., 1959).

The cell parameters, and observed and calculated densities of a lazulite $[Fe_{0.23}Mg_{1.77}Al_4(PO_4)_4(OH)_4]$, a scorzalite $[Fe_{1.23}Mg_{0.77}Al_4(PO_4)_4(OH)_4]$ and barbosalite $[Fe_2Fe_4(PO_4)_4(OH)_4]$ are tabulated, together with the atomic parameters of the lazulite and scorzalite. A drawing is given of the basic structure common to the three minerals, which all belong to space group $P2_1/c$.

R.F.S.Hearmon

539.2 : 548.7

3231 HIGH PRESSURE FORMS OF BPO_4 AND $BAsO_4$; QUARTZ ANALOGUES.
F.Dachille and L.S.D.Glasser.
Acta cryst., Vol. 12, Pt 10, 820-1 (Oct., 1959).

The unit cells, densities, and refractive indices are compared with those obtained by Mackenzie, Roth and Wentorf (Acta cryst., Vol. 12, Pt 1, 79, (Jan., 1959)). A.R.Stokes

539.2 : 548.7

3232 RARE EARTH ION RADII IN THE IRON GARNETS.
S.Geller and D.W.Mitchell.
Acta cryst., Vol. 12, No. 11, 936 (Nov., 1959).

539.2 : 548.7

3233 UNIT CELL AND SPACE GROUP OF ANHYDROUS FERROUS SULPHATE, $FeSO_4$. J.Coing-Boyat.
Acta cryst., Vol. 12, No. 11, 939 (Nov., 1959). In French.

539.2 : 548.7

3234 THE CRYSTAL STRUCTURE OF XANTHOPHYLLITE.
Y.Takéuchi and R.Sadanaga.
Acta cryst. Vol. 12, No. 11, 945-6 (Nov., 1959).

The crystal data are tabulated, together with data for two other brittle micas, margarite and seybertite.

539.2 : 548.7

3235 A NEW MODIFICATION OF ALUMINIUM ORTHOARSENATE. B.Sharan.
Acta cryst., Vol. 12, No. 11, 948-9 (Nov., 1959).

539.2 : 548.7

3236 A STUDY OF THE CRYSTAL STRUCTURE OF LORANDITE, $TlAsS_2$. A.Zemann and J.Zemann.
Acta cryst., Vol. 12, Pt 12, 1002-6 (Dec., 1959). In German.

The crystal structure of lorandite, $TlAsS_2$, has been solved in principle from (h0l) and (hk0) X-ray data. The essential features are screwed $As^{+}S_2$-chains parallel [010], which are bound together by irregularly coordinated Tl-atoms. The final R-values are: $R[010]=0.10_0$; $R[001]=0.17_8$.

539.2 : 548.7

3237 THE CRYSTAL STRUCTURE OF CADMIUM INDATE.
M.Skribljak, S.Dasgupta and A.B.Biswas.
Acta cryst., Vol. 12, Pt 12, 1049-50 (Dec., 1959).

539.2 : 548.7

3238 CRYSTAL STRUCTURE OF SILVER FULMINATE.
K.Singh.
Acta. cryst., Vol. 12, Pt 12, 1053 (Dec., 1959).

539.2 : 548.7

3239 THE DISTRIBUTION OF IONS AND THEIR VALENCIES IN MANGANESE FERRITES. I. $MnFe_2O_{4+\gamma}$ FERRITES.
S.Krupička and K.Závěta.
Czech. J. Phys., Vol. 9, No. 3, 324-31 (1959).

A model for the distribution of cations in the spinel lattice of these ferrites was elaborated on the basis of the experimental studies of the basic magnetic quantities, electrical conductivity and magnetic relaxation, taking into consideration their crystallographic properties. The conclusions following from this model are in good agreement with the experimental results obtained previously both for stoichiometric manganese ferrite and for a ferrite where γ is not zero.

539.2 : 548.74 : 538.2

NEUTRON STUDY OF THE CRYSTAL STRUCTURE OF $MnFe_{2-t}Cr_tO_4$. See Abstr. 1808

539.2 : 548.7

3240 RESOLUTION OF THE AMBIGUITY OF VALENCE STATES IN SPINELS CONTAINING MANGANESE AND IRON. A.Miller.
Phys. Rev., Vol. 116, No. 6, 1481-2 (Dec. 15, 1959).

The dilemma of whether $[Fe^{2+}Mn^{2+}]$ or $[Fe^{2+}Mn^{3+}]$ are the stably coexisting species on the octahedrally ligated sites of the spinel structure has been resolved by the application of a crystallographic, rather than a magnetic criterion. The solid solution systems

$$(Zn[Mn_2]O_4)_{1-x}\text{-}(Zn_{0.5}Ge_{0.5}[FeMn]O_4)_x$$

and

$$(Zn[FeMn]O_4)_x.(Zn_{0.5}Ge_{0.5}[Mn_2]O_4)_{1-x}$$

were synthesized, and their lattice constants were determined. The compositions in these systems for which cooperative tetragonal distortion occurs, due to the Jahn–Teller effect for Mn^{3+}, depend on whether $[Fe^{3+}\,Mn^{3+}]$ or $[Fe^{2+}\,Mn^{3+}]$ are stably coexisting species. The crystallographic findings are in complete agreement with the latter valence assignment. Furthermore, the axial ratios are found to be in quantitative agreement with the theory of cooperative distortions advanced by Wojtowicz, provided that the valence assignment $[Fe^{2+}\,Mn^{3+}]$ is assumed. The valence behaviour observed in the systems studied probably obtains for most other spinels in which iron and manganese coexist on the octahedrally ligated sites. Unlike magnetic criteria which have been proposed to clarify the valence assignment, the method reported is not subject to ambiguities such as the existence or nonexistence of complex ferrimagnetic coupling schemes (e.g., Yafet-Kittel angular coupling) and "spin quenching".

539.2 : 548.7

3241 SYMMETRY PROPERTIES OF THE WURTZITE STRUCTURE. M.L.Glasser.

J. Phys. Chem. Solids, Vol. 10, No. 2-3, 229-41 (July, 1959).

The space group of the wurtzite structure is considered, and character tables are given for the important symmetry elements in the Brillouin zone. Symmetrized combinations of plane waves are worked out for the most important points. A discussion is given of the probable forms of energy bands in wurtzite crystals.

539.2 : 548.7

3242 AN X-RAY STUDY OF NATURAL MONAZITE. II. SINGLE CRYSTAL DATA ON INDIAN MONAZITE MINERAL. J.Shankar and P.G.Khubchandani.

Proc. Indian Acad. Sci. A, Vol. 44, No. 3, 130-3 (Sept., 1956).

Rotation and Weissenberg pictures were taken of a thorium-bearing monazite single crystal. The cell parameters are $a_0 = 6.66$ A, $b_0 = 6.98$ A, $c_0 = 6.32$ A and $\beta = 76^\circ 38'$. The space group determined is $P2_{1/n}$ (C^5_{2h}).

539.2 : 548.7

3243 THE CRYSTAL STRUCTURE OF TETRAMETHYL-AMMONIUM TETRACHLOROZINCATE AND TETRACHLOROCOBALTATE. B.Morosin and E.C.Lingafelter.

Acta cryst., Vol. 12, Pt 8, 611-12 (Aug., 1958).

Structures were obtained from X-ray precession and Weissenberg photographs on the basis of their similarity to that of Cs_2ZnCl_4. Lattice parameters, positions of atoms, bond lengths and bond angles are tabulated. A.R.Stokes

539.2 : 548.7

3244 UNIT CELLS AND SPACE GROUPS FOR TWO ETHERATES OF SODIUM TRIDECAHYDRODECABORATE (1–). H.G.Norment, Jr.

Acta cryst., Vol. 12, Pt 9, 695 (Sept., 1959).

The mono-ethyl etherate, $NaB_{10}H_{13}(C_2H_5)_2O$, is triclinic (space group P1) with unit-cell parameters $a = 5.64 \pm 0.02$, $b = 7.42 \pm 0.02$, $c = 9.05 \pm 0.03$ A, $\alpha = 83^\circ 43' \pm 10'$, $\beta = 86^\circ 39' \pm 10'$, $\gamma = 74^\circ 0' \pm 10'$. The calculated and observed densities are 1.001 and 0.983 $g.cm^{-3}$ respectively. The bis-methyl etherate, $NaB_{10}H_{13}.2(CH_3)_2O$ is monoclinic (space group $P2_1/c$) with unit cell parameters $a = 11.49 \pm 0.02$, $b = 29.84 \pm 0.02$, $c = 9.72 \pm 0.02$ A, $\beta = 94^\circ 55' \pm 5'$. The calculated density is 0.946 $g.cm^{-3}$. R.F.S.Hearmon

539.2 : 548.7

3245 THE STRUCTURE OF THE COMPOUNDS OF IODINE WITH 1,4 DISELENANE AND 1,4 DITHIANE. J.D.McCullough, G.Y.Chao, and D.E.Zuccaro.

Acta cryst., Vol.12, Pt 10, 815-16 (Oct., 1959).

Crystallographic data are given for $C_4H_8S_2.2I_2$ and $C_4H_8Se_2.2I_2$, and a projection of the latter is shown. Comparisons are made with related compounds. A.R.Stokes

539.2 : 548.7

3246 DIMORPHISM AND ISOMORPHISM OF ZIRCONIUM (IV), CERIUM (IV), THORIUM (IV) AND URANIUM (IV) ACETYLACETONATES. D.Grdenić and B.Matković.

Acta cryst., Vol. 12, Pt 10, 817-18 (Oct., 1959).

It is shown by X-ray analysis that the Ce, Th, and U salts are isomorphous in the α-modification, and that the Zr and Th salts are isomorphous in the β-modification. For the structure of thorium salt see Grdenić and Matković [Nature (London) Vol.182, 465 (Aug. 16, 1958)]. A.R.Stokes

539.2 : 548.7

3247 ANHYDROUS BIS-SALICYLALDEHYDATO-NICKEL. F.K.C.Lyle, B.Morosin and E.C.Lingafelter.

Acta cryst., Vol. 12, No. 11, 938-9 (Nov., 1959).

The crystals are monoclinic, with 12 molecules in a cell of dimensions: $a_0 = 15.34$, $b_0 = 12.46$, $c_0 = 19.44$ A; $\beta = 97^\circ 8'$. The space group is Aa or A2/a.

539.2 : 548.7

3248 THE CRYSTAL STRUCTURE OF CERIUM TETRAKIS-DIBENZOYLMETHANE. J.Shankar and N.R.Kunchur.

Acta cryst., Vol. 12, No. 11, 940-1 (Nov., 1959).

539.2 : 548.7

3249 X-RAY STUDIES OF MOLECULAR OVERCROWDING. I. SOME CRYSTALLOGRAPHIC DATA. G.Ferguson and G.A.Sim.

Acta cryst., Vol. 12, No. 11, 941 (Nov., 1959).

With a view to obtaining detailed information about the effect on the molecular geometry of the close approach of neighbouring groups, a number of substituted benzoic acids have been studied. Lattice parameters and space groups are reported for four compounds.

539.2 : 548.7

3250 UNIT CELL AND SPACE GROUP OF L-PROLINE MONOHYDRATE. V.Sasisekharan.

Acta cryst., Vol. 12, No. 11, 941 (Nov., 1959).

539.2 : 548.7

3251 A REFINEMENT OF THE CRYSTAL STRUCTURE OF DIKETOPIPERAZINE (2,5-PIPERAZINEDIONE) R.Degeilh and R.E.Marsh.

Acta cryst., Vol. 12, Pt 12, 1007-14 (Dec., 1959).

The structure of 2,5-diketopiperazine, "glycine anhydride", first determined by Corey (1938) was refined on the basis of complete three-dimensional intensity data obtained from molybdenum X-radiation. The structural parameters for the heavy atoms, including individual anisotropic temperature factors, were refined by difference maps and least-squares methods; the positions of the hydrogen atoms were located from a difference map. The final R factor is 0.072 for 1144 observed reflections and the standard deviations in the positional parameters of the heavy atoms are about 0.0013 A. The structure is essentially that found by Corey with the exception of the observed length of the C–C bond which has changed from 1.47 to 1.499 A and of the $C(H_2)$–N bond which has changed from 1.41 to 1.449 A. Both of these distances are still significantly shorter than normal single-bond distances. The apparent N–H distance is 0.86 A and the apparent C–H distances are 0.93 and 0.95 A.

539.2 : 548.7

3252 X-RAY STUDIES ON THE METAL COMPLEXES WITH THE GLYOXIMES. II. STRUCTURE OF THE Pt-DIMETHYL-GLYOXIME. E.Frasson, C.Panattoni and R.Zannetti.

Acta cryst., Vol. 12, Pt 12, 1027-31 (Dec., 1959).

During a systematic investigation of the metal complexes of the glyoximes, the structure of Pt-dimethyl-glyoxime has been examined. It has the same space group Ibam as Ni-dimethyl-glyoxime. The lattice constants are a = 16.73, b = 10.59, c = 6.47 A; Z = 4. Such values are similar to those found in Ni-dimethyl-glyoxime. The molecule is planar and the Pt–Pt distances between metallic atoms of overlying molecules are 3.23 A. The intramolecular distance of 0.03 A between the oxygen atoms bound by a hydrogen bond, is significantly longer than the one in Ni-dimethyl-glyoxime (2.44 A) and in Cu-dimethyl-glyoxime (2.57-2.70 A).

539.2 : 548.7

3253 A REFINEMENT OF THE STRUCTURE OF ALLOKAINIC ACID. D.W.J.Cruickshank.

Acta cryst., Vol. 12, Pt 12, 1052 (Dec., 1959).

539.2 : 548.7

3254 THE STRUCTURE OF $SP(C_2H_5)_3$ AND $SeP(C_2H_5)_3$. M.Van Meerssche and A.Léonard.

Acta cryst., Vol. 12, Pt 12, 1053-4 (Dec., 1959). In French.

539.2 : 548.7

3255 HYDRATES OF THE TETRA n-BUTYL AND TETRA i-AMYL QUATERNARY AMMONIUM SALTS. R.McMullan and G.A.Jeffrey.

J. chem. Phys., Vol. 31, No. 5, 1231-4 (Nov., 1959).

The compounds $[(n\text{-}C_4H_9)_4N^+]_nX^{n-}.nyH_2O$ were prepared where X is F^-, Cl^-, Br^-, $CH_3CO_2^-$, CrO_4^{2-}, WO_4^{2-}, $C_2O_4^{2-}$, HCO_3^-, HPO_4^{2-}, and y is approximately 32. They form an isomorphous crystal series which is tetragonal with a = 23.65 ± 0.15 A, c = 12.40 ± 0.15 A. A similar series of the type $[(i\text{-}C_5H_{11})_4N^+]_nX^{n-}.ny'H_2O$ was prepared where X is F^-, Cl^-, CrO_4^{2-}, WO_4^{2-}, and y' is approximately 40. They also form an isomorphous group which is orthorhombic with a = 12.10 ± 0.10 A, b = 21.50 ± 0.15 A, c = 12.65 ± 0.15 A. These compounds are believed to be of the clathrate type, similar in general character to the gas hydrates.

539.2 : 548.7

3256 INTERMOLECULAR DISTANCES AND DIAMAGNETIC ANISOTROPY IN CRYSTALS AS MEASURES OF THE POLARITY OF BENZENE AND BORAZOLE SUBSTITUENTS. K.Lonsdale.
Nature (London), Vol. 184, 1060 (Oct. 3, 1959).

Discussion of 1:3:5-trichlorobenzene and B.B.B.-trichloroborazole.

539.2 : 548.7

3257 INFLUENCE OF THE SIZE OF THE HALOGEN ATOM ON THE DIFFERENCE BETWEEN LATTICE CONSTANTS OF COPPER DIPYRIDINE DICHLORIDE AND DIBROMIDE. V.Kupcik and S.Durovic.
Nature (London), Vol. 184, 1060-1 (Oct. 3, 1959).

539.2 : 548.7

3258 THE CRYSTAL STRUCTURE OF MAGNESIUM ACETATE-TETRAHYDRATE $Mg(CH_3COO)_2.4H_2O$. J.Shankar, P.G.Khubchandani and V.M.Padmanabhan.
Proc. Indian Acad. Sci. A, Vol. 45, No. 2, 117-23 (Feb., 1957).

The crystal structure of magnesium acetate has been completely determined. The crystals are monoclinic with space-group C_{2h}^5—$P2_1/c$ and two molecules in a unit cell with edges a = 4.75 A, b = 11.79 A, c = 8.52 A and β = 94° 54'. The positions of the atoms were determined from electron density projections on the bc and ac planes. From these the various bond lengths and angles were calculated.

VARIOUS SOLID STRUCTURES

539.213

3259 HUGONIOT CURVE OF VITREOUS SILICA AND CRYSTALLIZATION BY SHOCK. J.Viard.
C.R. Acad. Sci. (Paris), Vol. 249, No. 6, 820-2 (Aug. 10, 1959). In French.

The Hugoniot curve relating the pressure and the static compression has a discontinuity of gradient at 135 kilobars. This indicates that there is a transition in the shock wave from the vitreous to the crystalline state. B.T.M.Willis

539.213

3260 THE RELATIONSHIP BETWEEN THE ELECTRICAL CONDUCTIVITY AND VISCOSITY OF GLASSES. R.L.Myuller.
Fiz. tverdogo Tela, Vol. 1, No. 2, 346-7 (Feb., 1959). In Russian.

Discusses a temperature-independent constant n which occurs in the relationship between the electrical conductivity k and the viscosity v of glasses:

$$k^n v = C,$$

where C is another temperature-independent constant. Frenkel' (1945) showed that

$$n = 2E(T)/D(T),$$

where E(T) is the viscosity activation energy and D(T) is the dissociation energy of ions. The present note relates the constancy of n and the rise of E(T) and D(T) with temperature to structural changes in glass. A.Tybulewicz

539.213

3261 ON THE STRENGTH AND STRUCTURE OF GLASS. J.E.Gordon, D.M.Marsh and M.E.M.L.Parratt.
Proc. Roy. Soc. A, Vol. 249, 65-72 (Jan. 1, 1959).

The strength of glass is known to be very variable and also to be affected by the condition of the surface. By improving a technique of decoration with sodium, due originally to Andrade, elaborate crack systems have been revealed on the surface of drawn glasses. These crack systems are correlated with, and may control, the mechanical strength of glass. They also appear to indicate the existence of a tension layer on the surface of glass. The cracks seem to be 100 to 200 A wide and are probably at least 1000 A deep. Cracks can be initiated by local abrasion, but this is probably not the only cause. A technique for the examination of thin glass films by transmission electron microscopy has also been developed and has been used to observe the mechanism of devitrification in various glasses. The initiation of cracks in fine crystallites has been watched and such cracks have been seen to propagate from the crystalline to the glassy regions in silica. It is, therefore, possible that fine-scale devitrification on the surface of glass during drawing might provide an alternative mechanism to abrasion for the origin of the surface cracks.

539.213 : 535.37

3262 FLUORESCENCE AND ABSORPTION SPECTRA OF MOLECULAR COMPOUNDS IN GLASSY SOLUTIONS AT LOW TEMPERATURES. J.Czekalla, G.Briegleb and W.Herre.
Z. Elektrochem., Vol. 63, No. 6, 712-15 (1959). In German.

The fluorescence and absorption spectra of molecular compounds of chloranil, 2,5 dichloroquinone, 1,3,5 dinitrobenzene, tetrachlorophthalicanhydride and trimesictrichloride with durene, naphthalene, phenanthrene, anthracene and 1,2 benzanthracene in diluted solutions of n-propyl ether/isopentane were measured at −190° C. The fluorescence and absorption spectra have mirror symmetry indicating that the emission is a charge-transfer fluorescence. J.Franks

539.213 : 539.2 : 537.311

3263 GLASS-LIKE SEMICONDUCTORS. N.A.Gorjunova and B.T.Kolomijez.
Semiconductors and phosphors (See Abstr. 9597 of 1959) p. 678-84. In German.

Compounds lying in the following composition ranges were examined: As_2Se_3—Sb_2Se_3, As_2Se_3—Tl_2Se, As_2Se_3—As_2Te_3, As_2Se_3—As_2S_3, $As_2Se_3.Tl_2Se$—$Sb_2Se_3.Tl_2Se$, As_2S_3—Sb_2S_3. The ternary and quaternary systems were either crystalline or glass-like, with a well-defined composition boundary separating the two phases; however, for some compositions both phases were present. The electrical and optical properties of the compounds are briefly described. B.T.M.Willis

539.214

3264 DIFFUSION OF IMPURITIES IN AMORPHOUS POLYMERS. A.W.Lawson.
J. chem. Phys., Vol. 32, No. 1, 131-2 (Jan., 1960).

The data of Ryskin on diffusion of impurities into amorphous polymers appear to be consistent with the prediction of elastic continuum theory that the ratio of the entropy of activation, $\Delta S^\ddagger$, to the enthalpy of activation, $\Delta H^\ddagger$, is independent of the nature of the diffusing impurity. The ratio, $\Delta S^\ddagger/\Delta H^\ddagger$, depends only on the host polymer, and is approximately equal to 4α, where α is the volume thermal expansion coefficient of the polymer. The concentration dependence of the diffusion coefficient is roughly explained by the continuum theory on the basis of swelling.

539.217 : 539.2 : 537.311

STRUCTURE OF THE SYSTEM $AgSbTe_2$—PbTe. See Abstr. 2902

539.219

3265 THE NATURE OF CONTACT FUSION OF ALKALI-HALIDE CRYSTALS. P.A.Savintsev, V.E.Avericheva and V.Ya.Zlenko.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 828-30 (Aug. 1, 1959). In Russian.

Mixtures of halide powders in thin-walled silica tubes were heated to a certain temperature at which the X-ray photographs were taken. In the case of KCl-NaCl mixture, lines of solid solution replaced at 635°C those of the components. For KCl-KI, solid solutions of KCl in KI, and vice versa, were detected above 500°C. When monocrystals were kept for some time at a given temperature, brought into contact and again kept for some time at the same temperature, it was found by X-ray method that, for KCl-KBr, on the surface of the KCl crystal at a temperature 50° below the contact fusion point a solid solution formed, corresponding to that of the minimum in the fusion diagram of the KCl-KBr system. Similar results were obtained for NaCl-NaBr. Limited solid solutions were

obtained on the surfaces of both crystals in the case of KCl-KI. The phenomenon of contact fusion can be considered as bearing out the mutual solubility of the components; this is corroborated by measurements of the heat of formation of the solid eutectic alloys KCl-KI and KCl-K_2CrO_4. F.Lachman

539.219

3266 THE CHANGE IN PRIMARY EXTINCTION DURING DECOMPOSITION OF A SUPER SATURATED SOLID SOLUTION. I. SYSTEM Al–Ag. K.Toman.

Czech. J. Phys., Vol. 9, No. 3, 367-76 (1959).

On the basis of the correlation of diffraction data (intensity and width) of a precipitate with the intensity of reflection of a matrix solid solution, it is shown that the change in primary extinction during the decomposition of a solid solution of Ag in Al is caused by the precipitation of the phase Ag_2Al and not by the production of lattice defects (zones, stacking faults).

539.219

3267 THE CALCIUM SILICATE Mn + Pb PHOSPHOR PHASE RELATIONSHIPS AND PREPARATION.

D.E.Harrison and M.V.Hoffman.

J. Electrochem. Soc., Vol. 106, No. 9, 800-4 (Sept., 1959).

Phase relations were examined in the vicinity of $CaSiO_3$ in the system to pseudo-wollastonite inversion temperature. Addition of $MnSiO_3$ to (Ca,Pb) $CaSiO_3$–$MnSiO_3$–$PbSiO_3$. Lead solid solutions in $CaSiO_3$ lower the wollastonite SiO_2ss markedly lowers the solubility of lead in (Ca,Mn,Pb)SiO_2ss and causes a change in structure from pseudo-wollastonite to wollastonite. Application of the phase data is used to demonstrate how the synthesis technique can be varied to produce major differences in particle size of the phosphor.

539.219

3268 RANDOM CLUSTERS IN DISORDERED SOLID SOLUTIONS. P.G.de Gennes, P.Lafore and J.P.Millot.

J. Phys. Chem. Solids, Vol. 11, No. 1-2, 105-10 (Sept., 1959). In French.

Deals with some propagation phenomena in binary solutions AB, the wave being carried by A atoms only. Such a situation is encountered in impurity bands for semiconductors, and also for spin waves in alloys with one ferromagnetic component. It is found that below a critical percentage of A atoms (depending on the range of the couplings), the A atoms always belong to finite "clusters" (different clusters being unlinked by the wave-equation). The eigenvalues spectrum of the wave-equation is then discrete. Above the critical percentage, one finds both finite and non-finite clusters; the eigenvalue spectrum has a continuous component, and a finite static conductivity may occur.

539.219

3269 MERCURY PROCESS FOR MnBi PRODUCTION. A.Goldman and G.I.Post.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 204S-205S (April, 1959).

A method for producing manganese bismuthide has been investigated where in the manganese and bismuth are first "dissolved" in mercury by heating at atmospheric pressure. The mercury is subsequently vacuum distilled at a low temperature, leaving a strongly ferromagnetic residue of MnBi. The MnBi prepared by this method was shown to be identical with that prepared by other methods. X-ray diffraction showed only lines that could be attributed to MnBi. In addition, the lattice constants agreed with those reported by other investigators. The first anisotropy constant was determined for this material as well as for known MnBi. These anisotropies were found to be similar. The magnetic moment of the material produced by the mercury process was found to depend on the stoichiometry of the product, the maximum being obtained for that computed for the formula, MnBi.

539.219

3270 SOLUBILITY OF CARBON IN IRON AS DETERMINED BY THE MAGNETIC AFTEREFFECT.

J.Singer and E.S.Anolick.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 193S-194S (April, 1959).

A slightly lower ΔH of solution for carbide, presumably cementite, in pure iron, about 8000 cal/g atom than is given by internal friction was obtained by measurements of the time decay of permeability in infused carbon-iron Epstein samples. The method is independent of any assumption of proportionality between the time decay and dissolved carbon. While the lower ΔH may not be significant, the carbon solubility, e.g. 0.006% at 600°, is claimed to be significantly lower than the accepted internal friction values, e.g. 0.01% at 600°. Causes of the disagreement are suggested. The data also show that time decay of permeability is proportional to dissolved carbon.

539.219 : 539.5

3271 BRITTLENESS OF COBALT-IRON ALLOYS. C.W.Chen and G.W.Wiener.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 199S-201S (April, 1959).

The brittleness of several cobalt-iron alloys has been investigated. A theoretical evaluation of the hardening mechanism of isotropic short-range order and long-range order coupled with anisotropic short-range order is made for the stoichiometric composition CoFe. The critical shearing stresses associated with the mechanisms are estimated together with that of interstitial atoms. In the absence of the effect of interstitials and other interferences, the hardening mechanisms of order may give rise to the brittleness of Co–Fe alloys. Experiments on two Co–Fe alloys with the addition of Cr or V establish the embrittling action of hydrogen at the grain boundaries.

539.219

3272 DEVELOPMENT OF METALLURGICAL STRUCTURES AND MAGNETIC PROPERTIES IN IRON SILICON ALLOYS. R.H.Pry.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 189S-193S (April, 1959).

A brief history of the development of silicon iron alloys is given. The processes which lead to the development of strong textures of both the cube and cube-on-edge type are then reviewed and a comparison of some of the magnetic properties of textured silicon iron is presented. It is concluded that major technological and scientific opportunities still lie in the understanding of mechanism of texture development.

539.219

3273 EFFECT OF IMPURITIES ON THE TEMPERATURE DEPENDENCE OF THE (110)[001] TEXTURE IN SILICON-IRON. J.E.May and D.Turnbull.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 210S-212S (April, 1959).

Effects of impurities on the formation of the strong (110)[001] texture in silicon-iron were studied. It was observed that the temperature range in which the (110)[001] texture forms can be increased by varying the type and amount of impurity. The temperature at which the (110)[001] texture forms is proposed to be determined by the solubility of the impurity. It is proposed that the strong (110)[001] texture develops in silicon-iron because (110)[001] grains possess lower free energy even at the increased temperatures than grains in other orientations.

539.219

3274 ROOM TEMPERATURE DECOMPOSITION OF AUSTENITE IN FIFTY PERCENT NICKEL-FIFTY PERCENT IRON MAGNETIC ALLOY TAPES.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 202S-203S (April, 1959).

Upon room-temperature storage, austenitic, annealed fifty percent nickel-fifty percent iron magnetic alloys tapes have been found to show structural instability resulting in a slow and partial decomposition into an orthorhombic or tetragonal phase. The decomposition has so far been detected in 0.002 in. thick tapes from only one experimental and one commercial alloy. To date, covering a period of over three years, the decomposition appears to have progressed only very slowly and remains restricted to the surface of the tapes. The decomposition that has occurred in these tapes does not seem to have any measurable effect on their magnetic characteristics. Further studies of the influence of tape purity and of tape thickness upon the transformation and of the effect of any transformation in ultrathin tapes on their magnetic properties are being made.

539.219

3275 VARIATION IN ORIENTATION TEXTURE OF ULTRATHIN MOLYBDENUM PERMALLOY TAPE.

P.K.Koh, H.A.Lewis and H.F.Graff.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 208S-210S (April, 1959).

It is necessary to select certain heats of molybdenum Permalloy in order to manufacture cores of ultrathin tape which have satisfactory properties for use in computer applications. In an effort to aid this selection process, quantitative pole density stereograms of {111} poles of $\frac{1}{2}$ mil tapes from six production heats in both cold rolled and annealed conditions were developed in order to reveal possible variations in texture and magnetic properties. Cold

rolling the tape developed (110)[335] and (110)[33$\bar{5}$] end orientations as major texture components together with a previously unnoticed cube-on-edge or (110)[001] orientation as a minor texture component whose intensity varies according to a combination of many possible processing variables. Annealing the tape at 927°C developed (120)[001] + (210)[001]; (113)[7$\bar{8}$5] + (113)[78$\bar{5}$]; and previously unnoticed (110)[001] cube-on-edge texture components. The intensity of each individual texture component depends on the combined effect of many processing variables. Switching coefficient, squareness of hysteresis loop (Br/Bm) and coercive force were used as magnetic parameters for evaluation of the tape cores. It was found that among other possible combinations of texture components a strong (110)[001] annealed texture component seems to associate with the highest squareness ratio and lowest coercive force of the tapes studied in the present investigation. No correlation was found between texture and switching coefficient.

539.219

3276 PROGRESS IN ULTRATHIN Mo-PERMALLOY TAPES WITH SQUARE HYSTERESIS LOOPS.

M.F.Littmann and C.E.Ward.

J. appl. Phys., Supplement to: Vol. 30, No. 4, 213S-214S, (April, 1959).

Commercial production of ultrathin cold-rolled tapes of 4-79 Mo-Permalloy has been accompanied by research on melting, processing, and annealing procedures leading to improved quality control. A wide range of magnetic properties with pulse magnetization is available by selection of tape thickness and final annealing temperature of the cores. The effect of reduced thickness is a generally higher coercivity and increased squareness. The switching coefficient is lowest for $\frac{1}{8}$ mil tape, but at drives below about 0.25 Oe the switching time is not less than for $\frac{1}{4}$ mil because of the higher coercive force. With increasing temperature of the final anneal, both squareness (measured by static B_r/B_m ratio) and coercive force is accompanied also by a decrease in the switching coefficient until a minimum value of the switching coefficient is reached after which it decreases with further decrease in coercive force. This point of minimum switching coefficient appears to be related to a crystal structure in which the grains extend through the sheet thickness with minimum lateral growth. Data illustrative of the uniformity of static and dynamic magnetic properties between lots of material with present technology are given.

539.219

3277 SOME OBSERVATIONS ON EVAPORATED PERMALLOY FILMS. W.W.L.Chu, J.E.Wolfe and B.C.Wagner.

J. appl. Phys., Supplement to : Vol. 30, No. 4, 272S-273S (April, 1959).

Experimental study of the chemical and physical characteristics of evaporated Permalloy films have been carried out. Observations regarding chemical homogeneity, applied strains, and magnetic annealing are reported. Results showed that chemical heterogeneity could exist in such films; possible effects of heterogeneity are speculated. Longitudinal compressive strains, when applied to a magnetostrictive film, could markedly increase its magnetization reversal speed and change its preferred direction. Magnetic annealing of 75% Ni films at 300° C in a transverse field irreversibly changed the films' preferred directions by 90°, reducing the H_k's to 3.0 Oe, with maximum variations of ±0.5 Oe.

539.219 : 537.3 : 539.2

PHASE DIAGRAM OF THE SYSTEM Al–Zn. See Abstr. 2851

539.219 : 539.2 : 538.2

COBALT PRECIPITATES IN Cu–Co ALLOYS. See Abstr. 3016

539.23

3278 MEASUREMENT OF DISORDER ENERGY IN QUENCHED CONDENSED Cu AT LOW TEMPERATURE.

W.Mönch and W.Sander.

Z. Phys., Vol. 157, No. 2, 149-58 (1959). In German.

Copper films were produced by quenching condensation on a substrate at low temperature. A stored energy release of 216 cal/mole and a resistivity decrease of 1.8 μohm cm were observed during annealing from 20° to 60° K. In this temperature range the recovery of the films is described by a crystallization of highly disordered material between small crystallites, which are produced during condensation. About 14 atomic % of the whole film substance take part in this process. The stored energy–resistivity ratio $E/\Delta\rho$ found is 1.9 (cal/g)/(μohm cm) in the whole range from 20° to 60° K. This value is in good agreement with the stored energy measurements on neutron-bombarded copper.

539.23

3279 THICKNESS OF ANODIC OXIDE FILMS BY ELECTRON MICROSCOPY. S.Ohh and K.G.Carroll.

J. appl. Phys., Vol. 30, No. 10, 1620-1 (Oct., 1959).

During anodic oxidation of stainless steel films, initially 0.05 mm thick, very thin oxide films are obtained if all the metal is allowed to dissolve. Electron diffraction shows their composition to be $NiO.Cr_2O_3$. Electron micrographs show grain structure and sub-grain boundaries outlined by black dots about 0.1μ across. From electron transmission measurements, on the basis of the scattering theory of Lenz (Abstr. 7490 of 1954), the thickness of the oxide film was found to be 6.5 A in one specimen and 30 A in another. It is suggested that such films may be the cause of passivity in stainless steels. V.E.Cosslett

539.23

3280 CONTROL OF THE THICKNESS OF EVAPORATED LAYERS DURING EVAPORATION. G.Papp.

Rev. sci. Instrum., Vol. 30, No. 10, 911-12 (Oct., 1959).

A method is given with which the progress of evaporation can be checked at any moment simply by counting the number of interference fringes on a control plate located in the vicinity of the target.

539.23 : 539.16

3281 A NEW METHOD FOR THE PREPARATION OF THIN FILMS OF RADIOACTIVE MATERIAL.

D.J.Carswell and J.Milsted.

J. nuclear Energy, Vol. 4, No. 1, 51-4 (Jan., 1957).

The material to be deposited is ejected as an organic solution from a fine capillary by the application of an electric field, and collected on a metal plate. Thin α sources giving good resolution of α energies have been prepared by this method, which may have other applications in nuclear investigations.

539.23 : 621.397.331.2

3282 PRODUCTION OF FINE PATTERNS BY EVAPORATION. S.Gray and P.K.Weimer.

R.C.A.Rev., Vol. 20, No. 3, 413-25 (Sept., 1959).

In producing fine complicated patterns of conductors and insulators by evaporation through masks in vacuum, scattering of material from the masks and migration in the formed films can interfere with desired electrical, optical, and mechanical properties. Methods of measurement of scattering are presented. Scattering itself may be reduced by adjusting the properties of the mask and evaporation conditions. The effects of scattering can be reduced by treatment of the workpiece, as by heat treatment of a conducting pattern. Migration of silver can break down electrical insulation. Diffusion of aluminium into cryolite has been used to produce reverse patterns. Many of these techniques have been applied to the construction of an experimental target for a tricolour pickup tube, which includes an array of interference filter strips registered with which are strips of semitransparent gold electrically connected in three groups. The width of the filter strips is 0.0007 in. Each gold strip is 0.0005 in. wide and is insulated from its two neighbours across a gap of 0.0002 in.

539.23

3283 STRUCTURE AND RESISTANCE OF VERY STRONGLY DISORDERED Cu FILMS AT LOW TEMPERATURES.

E.Feldtkeller.

Z. Phys., Vol. 157, No. 1, 65-78 (1959). In German.

Copper and silver films were condensed with admixtures of of SiO, LiF, Cu_2O and Fe on to a substrate at 4° K. For a film with 16 atomic % SiO, electron diffraction pictures at 4° K show a nominal crystallite size of 7 A. This means that, even over small regions, there is no well-defined lattice order. Such films have resistivities about 1500 times higher than that of the bulk metal at room temperature. The resistivity decreases on heating. Its temperature coefficient is negative also when the film is cooled again. The films are not so strongly disordered if only 9 atomic % SiO is admixed. In addition, a dependence on evaporation temperature has been observed. LiF and Cu_2O produce less disorder than SiO. Different interpretations of these observations are discussed. The results with Fe show that solid solutions of high concentration can be obtained by condensing films on to very cold substrates, even when the solution components are only slightly soluble in one another at thermal equilibrium.

X-ray and Electron Microscope Examination

539.26

3284 QUANTITATIVE METHOD FOR DETERMINATION OF FIBRE TEXTURE IN WIRES. I. PRINCIPLE OF METHOD AND ANALYTICAL EXPRESSION OF ABSORPTION FACTOR. V.Syneček.
Czech. J. Phys., Vol. 9, No. 6, 736-46 (1959).

An X-ray diffraction method is described for the quantitative determination of the fibre texture in cylindrical specimens (wires), which does not require specimen preparation. The integrated intensity of the diffracted radiation from a certain atomic plane is measured in the direction parallel to the plane determined by the axis of the wire and by the direct beam for different orientations of the axis of the wire. These measurements can be carried out in practice using an X-ray counter diffractometer or Weissenberg goniometer. The pole figure is determined from the dependence of the diffracted intensity on the orientation of the wire after correcting the intensities for the absorption of radiation in the specimen. The geometric arrangement enables the absorption factor to be calculated analytically. Its form was verified experimentally by measuring the dependence of the intensity of the 220 reflection on the orientation of the axis of a cylindrical specimen of Al containing randomly oriented crystals.

539.27

3285 ELECTRON MICROSCOPICAL INVESTIGATION OF CLEAVAGE FACES OF INDIUM ANTIMONIDE SINGLE CRYSTALS.
A.Feltynowski and L.Górski.
Exper. Tech. der Phys., Vol. 7, No. 3, 97-104 (1959). In German.

A Zaponlack-aluminium two-stage replica method was used to study the structure of cleavage faces of indium antimonide single crystals grown by the zone melting process. Areas of interest were first selected with the optical microscope. Cleavage steps and slip lines are found, of similar form to those seen in metals. Two systems of slip lines were observed, arising from two different sets of slip planes. It is suggested as a useful method for investigating defects in single crystals of semiconductors generally.

V.E.Cosslett

539.27

3286 AN INTERPRETATION OF "FEATHER-LIKE PATTERNS" OBSERVED ON AN ELECTRON MICROGRAPH OF MoO_3 CRYSTALS. E.Pernoux.
J. Phys. Radium, Vol. 18, No. 12, 672-5 (Dec., 1957). In French.

539.27

3287 ELECTRONIC DODGING OF ELECTRON DIFFRACTION AND ELECTRON MICROSCOPE PICTURES.
R.Thun, G.Hass and D.R.Craig.
Rev. sci. Instrum., Vol. 130, No. 10, 913-15 (Oct., 1959).

In electron microscopy and electron diffraction studies, problems of image contrast are frequently encountered. In microscopy numerous objects exhibit, for instance, only low contrast insufficient for a full resolution of the potentially available detail. In diffraction, on the other hand, the sharp decrease of diffraction line and background intensities toward larger scattering angles requires, for a faithful reproduction, density ranges often not available in photographic emulsions. The detail contrast can be enhanced, however, with the aid of a recently developed electronic dodging apparatus called Logetron. The function of this device is described, and its application in electron microscopy and electron diffraction is shown on a few selected examples.

539.27

3289 AN OBJECT CHAMBER WITH UNIVERSAL MOVEMENT OF THE SPECIMEN STAGE FOR ELECTRON DIFFRACTION EXPERIMENTS. W.D.Riecke and F.Stöcklein.
Z. Phys., Vol.156, No.2, 163-78 (1959). In German.

A new specimen stage with highly accurate adjustments has been developed for reflection electron diffraction. Rotational motions in azimuth through 360^0 and in inclination to the beam of $\pm 5^0$ are provided, both to within 5' accuracy. Traversing motions in two mutually perpendicular directions in the specimen plane have an amplitude of $\pm$ 2 mm, and the height adjustment extends to $\pm$ 2.5 mm, both readable to 5 μ. During diffraction the object can be observed simultaneously with an optical microscope in order to select areas of interest. The object chamber is built into a horizontal electron optical bench, with which an illuminating spot of 1 μ diameter is obtained. Applications will be described in a later paper.

V.E.Cosslett

539.27

3288 SPECIMEN HOLDER FOR CONTROLLED DEFORMATION IN THE ELMISKOP. R.M.Fisher.
Rev. sci. Instrum., Vol. 30, No. 10, 925-6 (Oct., 1959).

A specimen holder has been constructed to permit controlled deformation of thin metal films in the Siemens Elmiskop. The design details are described and the performance is illustrated.

539.27

3290 RESOLVING POWER OF TITANIUM REPLICAS USED IN ELECTRON MICROSCOPY.
A.N.Pilyankevich.
Zh. tekh. Fiz., Vol. 29, No. 9, 1156-8 (1959). In Russian.

The resolving power of a vacuum-deposited Ti replica of hardened 2% Be–Cu alloy was determined by microphotometric analysis. The experimental value of 60 A was in good agreement with that of 55 A calculated by the method proposed by Cathit (1951).

M.H.Sloboda

539.27 : 621.9

A NON DESTRUCTIVE TECHNIQUE FOR EXAMINING SURFACES: APPLICATIONS TO METALLURGY AND MECHANICS.
See Abstr. 2064

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

541.11

3291 STUDIES OF THE EVAPORATION OF CONDENSATES CONTAINING NITROGEN ATOMS.

J.T.Herron and V.H.Dibeler.

J. chem. Phys., Vol. 31, No. 6, 1662-5 (Dec., 1959).

The products of an electrodeless discharge in nitrogen or mixtures of nitrogen in neon or argon were condensed at 4.2°K. The products evolved from this condensate when it was allowed to warm up slowly were continuously analysed by means of a mass spectrometer having a lower detection limit of 2×10^{-5} mm of nitrogen atoms. Experimental evidence is presented for the presence of nitrogen atoms in the warmup products. It was estimated that less than 10^{-3}% of the nitrogen atoms originally condensed could be recovered.

541.12

3292 POSSIBLE CHEMICAL REACTION OF ORTHO-POSITRONIUM WITH OXYGEN. D.A.L.Paul.

Canad. J. Phys., Vol. 37, No. 9, 1059-60 (Sept., 1959).

Two further measurements (Abstr. 6134 of 1958) have been made on the quenching of orthopositronium by oxygen, at 77.5°K and 64.7°K in liquid N_2. It is plausible that a chemical compound $(e^+e^-)O_2$ may be formed, similar to the hydrogen analogue, hydroperoxo HO_2, which has been detected experimentally.

G.I.W.Llewelyn

541.12

3293 A CALCULATION OF THE RATES OF THE ORTHO–PARA CONVERSIONS AND ISOTOPE EXCHANGES IN HYDROGEN. I.Shavitt.

J. chem. Phys., Vol.31, No.5, 1359-67 (Nov., 1959).

The rates of the various elementary reactions of the type $H + H_2 \rightarrow H_2 + H$, involving ortho–para conversions or isotope exchanges, have been calculated by the absolute reaction rate theory, using new fundamental quantum-mechanical data for the shape of the H_3 energy surface, but estimating the activation energy to fit experimental results. The transition complex is linear and symmetric, in contrast with the asymmetric complex of the semiempirical surface, resulting in some qualitative, as well as quantitative, differences in the calculation. The tunnel effect correction is computed exactly, on the assumption that the potential barrier is of the Eckart type. The disparity between the experimental results obtained by different authors and the probable inaccuracies in their data make it very difficult to assess the accuracy of the calculated rate constants.

541.12

3294 ENERGY DISTRIBUTION AMONG REAGENTS AND PRODUCTS OF ATOMIC REACTIONS. J.C.Polanyi.

J. chem. Phys., Vol.31, No.5, 1338-51 (Nov., 1959).

A simple valence bond resonance description of the activated complex in exothermic reactions $A + BC \rightarrow AB + C$, coupled with experimental and theoretical evidence concerning the efficiency of transfer of vibrational energy at a collision, leads to the prediction that almost the entire heat of reaction will be contained in vibration of the bond being formed. The predicted activated complex configuration, which involves extended internuclear separation in the bond being formed, may be connected with increased collision diameters. The high efficiency of association reactions $A + A + M \rightarrow A_2 + M$ requires that in these reactions also the product contains almost the entire heat of reaction in vibration of the bond being formed. An attempt is made to account for the hitherto unexplained negative activation energy of these reactions in terms of the collisional redissociation of the highly vibrating product; a value for E_{act} of the required order of magnitude is obtained. The rate of the endothermic processes which constitute the reverse of the above reactions will be greatest if the molecule under attack is vibrationally excited. This is discussed in relation to the rate equation and is illustrated from experiment. For "linear" reaction the argument of the paper can be formulated in terms of potential energy surfaces; this is done in order to illustrate points of similarity and divergence from earlier theories. Further evidence is adduced for the predicted activated complex configuration by an alternative method of calculation applied to the reaction $H + Cl_2 \rightarrow HCl + Cl$. Twenty-three particular cases exothermic exchange reactions and association reactions are discussed, in each of which some experimental evidence exists for the presence of more than equilibrium vibrational energy in the bond formed.

541.12

3295 PARTICIPATION OF VIBRATION IN EXCHANGE REACTIONS. F.T.Smith.

J. chem. Phys., Vol.31, No.5, 1352-9 (Nov., 1959).

Exothermic exchange reactions of the type $A + BC \rightarrow AB + C$ sometimes leave the product AB in a highly excited vibrational state. Simple theoretical considerations related to the description of the molecular collision show that the fraction of the reaction energy available for this vibrational mode is limited by the kinematic factor $\sin^2\beta$, where β is the angle of rotation required to take a coordinate system describing the reactants into one suited to the products, and $\tan^2\beta = (m_B/m_A) + (m_B/m_C) + (m_B^2/m_A m)$. In the reaction $A + BCD \rightarrow AB + CD$, similar results apply to the newly formed bond AB, and no excitation of vibration in CD is predicted. Although effects to be expected from details of the potential energy surface are ignored, comparison of the kinematic factor alone with experimental results show excellent agreement. Applied to the reverse reaction, the theory gives a criterion for predicting the effect on the reaction rate of the distribution of energy between translational and vibrational modes in the collision. In the reaction $O_2 + O_2^* \rightarrow O + 2O_2$, it is predicted that the oxygen atom comes preferentially from the vibrationally excited oxygen molecule. Incidentally, it is shown that the transformation from a properly normalized centre-of-mass coordinate system describing the reactants to one describing the products can always be resolved into a sequence of simple rotations.

541.12

3296 DIFFUSION AND CHEMICAL REACTION IN A ONE-DIMENSIONAL CONDENSED SYSTEM.

I.Prigogine and T.A.Bak.

J. chem. Phys., Vol. 31, No. 5, 1368-70 (Nov., 1959).

A theory of diffusion processes and chemical reactions based on an integration of the Liouville equation is proposed. A diffusion equation for the probability density in phase space is obtained, and the equation is integrated for a special set of boundary conditions which express that the particle disappears when it reaches a critical energy. It is shown that the rate with which it is annihilated, which is an estimate of the rate of escaping a potential minimum, is characterized by an activation energy, and that the pre-exponential factor is strongly dependent on the frequency for the motion of the particle in the potential minimum. For the special case of an unperturbed potential which is harmonic this can be interpreted as a mass dependence, and it is found that the pre-exponential factor is inversely proportional to m^2.

541.12

3297 COMPARISON OF HOT AND THERMAL REACTIONS. J.L.Magee and W.H.Hamill.

J. chem. Phys., Vol. 31, No. 5, 1380-6 (Nov., 1959).

Recent experimental studies of the reaction probability of "hot" reactions make possible a detailed comparison of collision yields of hot and thermally activated H and CH_3 radicals. The theoretical basis of the comparison is first examined using the absolute reaction rate theory. It is found that there is a formal similarity of the rate constant for an energetic complex and a thermally activated complex in terms of a "temperature" θ for the former. The concept of "temperature" of an energetic complex is considered. The existing experimental data are in agreement with the theory if the assumption is made that a minimal number of degrees of freedom are effective.

541.12

3298 THEORY OF THERMAL SECOND-ORDER DECOMPOSITION OF MOLECULES. E.E.Nikitin and N.D.Sokolov.

J. chem. Phys., Vol. 31, No. 5, 1371-5 (Nov., 1959).

A discussion is given of the rate of dissociation of diatomic molecules through collisions with a third body, taking into account the perturbation from the equilibrium Boltzmann distribution of the levels near the dissociation limit. An expression is derived for the rate of dissociation and it is compared with experimental results. Certain differences between association and dissociation are pointed out. Similar ideas are applied to the decomposition of polyatomic molecules, and a correction for quantization is introduced. After

this correction, the results are shown to agree with the experimental data on several decompositions where the rate-determining step is the transfer of energy from some other molecule.

541.12

3299 VIBRATIONAL DISTRIBUTION FUNCTIONS IN BIMOLECULAR DISSOCIATION REACTIONS. K.E.Shuler.
J. chem. Phys., Vol. 31, No. 5, 1375-9 (Nov., 1959).

The "ladder climbing" model of Montroll and Shuler for the dissociation of diatomic molecules is used to evaluate the perturbation of vibrational distribution functions of diatomic oscillators in a bimolecular dissociation reaction. Explicit results are exhibited for the perturbation of initial Boltzmann and δ-function distributions of the oscillators. A limited tabulation of the roots of the Gottlieb polynomials employed in this calculations is presented.

541.12

3300 MEAN-FIRST-PASSAGE TIMES AND THE COLLISION THEORY OF BIMOLECULAR REACTIONS. B.Widom.
J. chem. Phys., Vol.31, No.5, 1387-94 (Nov., 1959).

A general collision theory is outlined for the kinetics of reaction of molecules which are dilutely dispersed in an inert gas, reaction being the result of binary collisions between the reacting molecules and the inert gas molecules. It is assumed that the products of reaction are instantaneously removed from the system. The mean-first-passage time for the transition from reactant to product states is expressed in the classical theory in terms of the solution of an integral equation in which the kernel is the transition probability per unit time between two states of the reacting molecule. As shown by Kim, when a rate constant exists (which is not always the case) it is the reciprocal of the mean-first-passage time. In a one-dimensional system, or in a system of two or three dimensions where the interaction between colliding molecules has a finite range, there exists a finite collision number Z which is independent of the internal state of the reacting molecule. In such a case there is a Liouville–Neumann solution of the integral equation which allows the mean-first-passage time to be expressed as a sum of contributions corresponding to failure to react after no collisions, after one collision, after two collisions, etc. The equilibrium hypothesis is analysed and it is seen what the precise nature of that approximation is. The theory is illustrated with each of two transition kernels, both satisfying the conditions of completeness and detailed balance. The first is a very simple but physically unrealistic one in which the transition probability depends only on the final state but not on the initial state, and here it is found that the equilibrium hypothesis yields the exact rate constant without error. The second illustration uses the previously calculated transition probability for a one-dimensional string oscillator suffering impulsive collisions with particles of mass identical to its own, and counts the oscillator as "dissociated" when its energy exceeds a certain critical energy ϵ^*. Here, as is obvious, the equilibrium hypothesis is correct when $\epsilon^* \gg kT$, and it is found that in this range the rate constant for dissociation is

$$Z(kT/\pi\epsilon^*)^{1/2}\exp(-\epsilon^*/kT).$$

It is shown in an appendix that if instead of just formally calling the oscillator dissociated when its energy exceeds ϵ^*, one actually specifies that the string is then ruptured, the basic transition probability is altered, and the equilibrium hypothesis then yields for the dissociation process the even simpler rate constant $Z\exp(-\epsilon^*/kT)$.

541.12

3301 BIMOLECULAR REACTION RATES IN SOLIDS AND LIQUIDS. T.R.Waite.
J. chem. Phys., Vol. 32, No. 1, 21-3 (Jan., 1960).

(1) Calls attention to the fact that bimolecular reactions ($A + B \rightarrow AB$) in solids and liquids do not, in general, follow simple second-order kinetics and, (2) discusses some of the complications arising when deviations occur. In a previous paper a general expression for the rate in bimolecular reactions in liquids and solids was derived. The general reaction rate is second-order in the concentrations but the "rate constant" is time dependent. That expression is simplified and presented here in terms of three physically significant parameters, D, the sum of the diffusion coefficients of species A and B, r_0 the A–B capture radius, and s, the ratio of the probability that a pair of particles A–B separated by a capture radius r_0 will react, to the probability that they will diffuse apart before reaction can occur. The dependence of the "rate constants" on these parameters and on the time is illustrated graphically. The physical significance of the limiting cases is discussed. A simple, accurate, physically meaningful approximation to the rather abstract general rate expression is presented. An experimental method of distinguishing bimolecular reactions when they do not follow simple second-order kinetics is discussed. Reactions involving particles with long-range forces are considered briefly.

541.12

3302 ON CHEMICAL REACTIONS IN FREE MOLECULE FLOW. P.L.Chambré.
J. chem. Phys., Vol. 32, No. 1, 24-7 (Jan., 1960).

Deals with heterogeneous chemical reactions within systems in which the relevant geometric dimensions are small compared with the mean free path of gas molecules. A typical example can be found in a surface reaction occurring at moderate pressures inside the pore of a catalyst with a radius of several angstroms. Specific problems of this type have in the past been formulated, subject to the well-known limitations of ordinary diffusion theory, in terms of differential equations for the species concentrations. This in turn supposes that the reaction pattern is dependent on local conditions. A more general and exact formulation is given in the paper, showing that the concentration of a molecular species at a point is determined by the concentration distributions of all species stemming from the entire system. Thus one is led to a formulation in terms of integral equations. In an application of the theory the validity of the conventional differential equation approach is investigated and is found to yield satisfactory results only under certain limiting conditions.

541.12

3303 QUANTUM-MECHANICAL CALCULATION OF THE PROBABILITY OF AN EXCHANGE REACTION FOR CONSTRAINED LINEAR ENCOUNTERS. J.Mazur and R.J.Rubin.
J. chem. Phys., Vol.31, No.5, 1395-412 (Nov., 1959).

A numerical procedure suitable for use with a high-speed computing machine is developed for calculating the average quantum-mechanical probability of the exchange reaction $BC + A \rightarrow B + CA$ for constrained linear encounters at temperature T when BC is initially in its ground or first excited vibrational state. The average refers to the average over the relative momentum frequency distribution of collisions between BC and A at temperature T. The procedure, which involves the numerical solution of the time-dependent Schrödinger equation, is sufficiently general so that any three-atom potential energy surface may be used. Two sample calculations have been performed using a simple potential energy surface. The results of these quantum-mechanical calculations for the average probability of reaction are compared with the corresponding classical quantities which are obtained in an elementary fashion.

541.12

3304 INVESTIGATION OF THE INTERACTION OF ALKYL IODIDE VAPOURS WITH A CARBON SURFACE BY KINETIC AND ISOTOPIC METHODS.
I.Kende, L.Guczi and D.Gál.
J. Phys. Chem. Solids, Vol. 10, No. 4, 321-5 (Aug., 1959).

The rate of desorption of ethyl, propyl and butyl iodides adsorbed by active carbon was examined at various temperatures. From the desorption curves obtained, the kinetic equation of desorption, the activation energies of desorption and the corresponding partition functions were determined.

541.12

3305 USE OF THE DIFFERENTIAL ISOTOPE METHOD FOR STUDYING THE INTERACTION BETWEEN VAPOURS OF ALKYL IODIDE AND SURFACE OF RED PHOSPHORUS.
L.Guczi, I.Kende and D.Gál.
J. Phys. Chem. Solids, Vol. 10, No. 4, 326-32 (Aug., 1959).

The kinetic curves of the desorption of ethyl, n-propyl and n-butyl iodides on red phosphorus at 40, 60 and 100°C were determined. From these and from the rate-of-desorption curves the partition functions were obtained, giving desorption energies and activation energies for the desorption processes. Making use of a radioactive iodine isotope, the differential isotope method was applied to studies of the interaction between alkyl iodides and the surface of red phosphorus. The experimental results seem to indicate that the surface of red phosphorus is heterogeneous, and that, in addition to adsorption, certain chemisorption processes also take place, leading to cleavage of the C–I bond in the molecules of alkyl iodides.

541.12

3306 HEAT OF MIXING OF LIGHT AND HEAVY WATER. V.P.Skripov.

Zh. eksper. teor. Fiz., Vol.35, No.5 (11), 1204-5 (Nov., 1958). In Russian. English translation in Soviet Physics–JETP (New York), Vol.35(8), No.5, 903 (May, 1959).

When equimolar quantities of H_2O and D_2O are mixed it is found that 7.92 ± 0.25 cal are absorbed per mole of HDO formed. Using a value K = 3.26 for the equilibrium constant of the reaction a further calculation (it is claimed) would enable conclusions to be drawn regarding the difference in the zero-point energies of the different isotopic forms of water molecules. W.Good

541.12

3307 KINETICS OF THE HYDROLYSIS OF ACETYL CHLORIDE. E.J.Cairns and J.M.Prausnitz.

J. chem. Phys., Vol. 32, No. 1, 169-75 (Jan., 1960).

The hydrolysis of acetyl chloride in mixed solvent of acetone-water was investigated by means of an electrical conductance method. The temperature was varied over the range of −35°C to +10°C, and the solvent composition was varied over the range of 10 to 25% of water by volume. The reaction was found to be first order with respect to water and first order with respect to acetyl chloride over the range investigated. A strong dielectric constant influence was found, manifesting itself in an influence on the iso-dielectric entropy of activation. This effect was consistent with electrostatic theory and followed the dipole–dipole type of dielectric constant dependence. The dipole moment of the activated complex was estimated to be 16 debye.

541.12

3308 KINETICS OF STRONTIUM OXIDE ON TUNGSTEN. J.A.Cape and E.A.Coomes.

J. chem. Phys., Vol. 32, No. 1, 210-14 (Jan., 1960).

Field electron microscopy was used to study the kinetics of strontium oxide on tungsten in the range 900-2200°K. Reactions take place on the {111} and {100} which have high concentrations of four nearest neighbour surface atoms. Below 1150°K there is some evidence for the dissociation of SrO and migration of Sr to the {110} edges where clusters of crystallites are formed. Two modifications of field emission patterns associated with the (Sr–O–W) complex within 1150-1550°K are tentatively identified with the basic and normal tungstate; apparently the first goes over to the second with an activation energy of ~ 60 kcal as determined from desorption data. An unusually sharp decrease in Fowler–Nordhein work function occurs during this reaction. In the later stages of desorption above 1550°K patterns identifiable with an oxygen-tungsten surface are obtained. Desorption at this stage takes place with an activation energy of ~ 140 kcal.

541.12

3309 KINETICS OF THE SURFACE DEGRADATION OF POLYMETHYLMETHACRYLATE. R.F.Chaiken, W.H.Andersen, M.K.Barsh, E.Mishuck, G.Moe and R.D.Schultz.

J. chem. Phys., Vol. 32, No. 1, 141-6 (Jan., 1960).

The surface degradation of both linear and crosslinked polymethylmethacrylate (PMM) was studied over the surface temperature range of 550° to 910°K by means of a hot-plate pyrolysis technique. It was demonstrated that surface gasification due to the high heat flux at the decomposing PMM surface involves a depolymerization process and surface desorption of methylmethacrylate monomer. The apparent activation energy for the linear rate of regression of the solid PMM surface (linear pyrolysis rate) was found to decrease with increasing surface temperature, approaching a limiting constant value of 11.2 ± 0.6 kcal/mole at ~ 650°K for linear PMM and at ~ 770°K for crosslinked PMM. The mechanism for the surface degradation is depicted as (1) formation of monomer in the surface substrate, (2) diffusion of monomer to the surface, and (3) desorption of monomer from the surface. The linear pyrolysis rate data are correlated by means of an absolute rate theory treatment of surface decomposition. The experimental results are in good agreement with the theory.

541.12

3310 PARAMAGNETIC RESONANCE IN CHARRED DEXTROSE. R.C.Pastor and R.H.Hoskins.

J. chem. Phys., Vol. 32, No. 1, 264-9 (Jan., 1960).

The magnetic-resonance properties of charred dextrose outgassed in high vacuum were studied. Linewidth measurements in conjunction with elementary analyses for two series of chars provide some evidence of the effect of cyclization on the observed widths. Low-temperature measurements of T_1 (c-w and direct pulse) have provided a better understanding of the nature of the distribution and saturation behaviour of the spin systems.

541.12

3311 THE EFFECT OF CHANGE OF THE ELECTRON CHEMICAL POTENTIAL LEVEL ON THE ACTIVITY OF SEMICONDUCTIVE CATALYSTS. G.K.Boreskov.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 3, 591-4 (July 24, 1959). In Russian.

The relationship between the adsorption and desorption rates, the electron work function, and the degree of surface coverage was studied analytically for the simple case of chemisorption of particles A involving the formation of charged particles A^+ on the catalyst surface. The results were applied to explain the variation of the activity of oxide catalysts in isotope exchange reactions in molecular hydrogen, and it was shown that as a result of lowering the chemical potential level the activation energy of adsorption is increased, and that of desorption decreased. Correspondingly, lowering the chemical potential level should increase the catalytic activity in the region of low surface coverage, and to produce an opposite effect in the region of high surface coverage.

M.H.Sloboda

541.12

3312 METHOD FOR THE STUDY OF DEFLAGRATION TO DETONATION TRANSITION.

F.C.Gibson, M.L.Bowser and C.M.Mason.

Rev. sci. Instrum., Vol. 30, No. 10, 916-19 (Oct., 1959).

A method based on the variation of electrical resistance in a wire element introduced into the charge has been developed for the continuous measurement of burning and detonation rates in opaque materials. The method has been used to obtain data on nonsteady-state phenomena in high explosives, in composite propellants and in liquid fuel-solid oxidizer mixtures. Composite propellants were found to be readily detonable when modified by the introduction of voids. Studies on liquid fuel-solid oxidizer mixtures, with bubbles of inert gas as well as voids, gave similar results.

541.12

3313 PRECISION HIGH-VELOCITY DETONATING CORD. G.R.Abrahamson and G.B.Huber.

Rev. sci. Instrum., Vol. 30, No. 10, 934-6 (Oct., 1959).

The accuracy of time delays which utilize detonating cord as the timing element is limited primarily by variations in detonation rate. A commercial detonating cord consisting of a small core of granular PETN explosive within a cylindrical lead sheath has an average detonation rate of 6275 m/sec with a range of 170 m/sec. By subjecting this material momentarily to a hydrostatic pressure of 55 000 lb/in², the detonation rate (after removal from the pressure chamber) is increased to 8140 m/sec and the range is decreased to 25 m/sec. Thus timing error due to detonation rate variation is reduced ninefold. These effects are attributed to increased density and decreased density variations of the explosive core. The change in detonation rate of pressed detonating cord with temperature is found to be 0.16 to 0.19 m/sec per °F. This effect appears to be due primarily to density changes induced in the explosive core by the expansion and contraction of the lead sheath.

541.12

3314 BURNING RATES OF SOLID PROPELLANTS. G.Rosen.

J. chem. Phys., Vol. 32, No. 1, 89-93 (Jan., 1960).

The burning mechanism of a solid-propellant is described in terms of a pyrolysis law, a premixed laminar flame, and nothing more. A quantitatively accurate burning rate formula is derived from the theory. The predicted burning rate pressure dependence agrees with the experimental results for ammonium perchlorate propellants.

ELECTROCHEMISTRY

541.13

3315 THE ACCURATE NUMERICAL SOLUTION OF THE POISSON–BOLTZMANN EQUATION. E.A.Guggenheim.
Trans Faraday Soc., Vol. 55, Pt 10, 1714-24 (Oct., 1959).

The Poisson–Boltzmann equation formulated by Debye and Hückel (Abstr. 2328 of 1923) has been accurately solved numerically and the result compared with the solution in series obtained by Gronwall.

541.13 : 574

3316 SIMPLE TECHNIQUE TO CONTROL THE STRAY FIELD OF ELECTROLYTIC CELLS. H.P.Schwan and J.Maczuk.
Rev. sci. Instrum., Vol. 31, No. 1, 59-62 (Jan., 1960).

The technique is particularly useful in biological impedance work and in determinations of the dielectric constant of solutions of high conductivity. It is based on a plot of the apparent dielectric constant as a function of electrode distance. In a logarithmic presentation the apparent dielectric constant appears as the sum of the true dielectric constant and two linear functions, representative of electrode polarization and stray field component. A few examples are given to illustrate the technique and its limitations.

PHOTOCHEMISTRY RADIATION CHEMISTRY

541.14

3317 EFFICIENT FLASH PHOTOLYSIS SYSTEM.
R.J.Charlson, H.Harrison and R.Hardwick.
Rev. sci. Instrum., Vol. 31, No. 1, 46-8 (Jan., 1960).

A flash tube of annular design, improved flash circuitry, and a photomultiplier enabler circuit are described. Results obtained with this apparatus indicate that the system quickly delivers a large number of photons into an absorption cell (viz., $\sim 6 \times 10^{16}$ photons/cm^3 with about 5 μsec 1/e time and 50 μsec total decay time) and is thus suited for studies of fast photochemical kinetics.

541.14

3318 PHOTOCHEMICAL FORMATION OF ORGANIC COMPOUNDS FROM MIXTURES OF SIMPLE GASES.
W.Groth and H.v.Weyssenhoff.
Ann. Phys. (Leipzig), Folge 7, Vol. 4, No. 1-5, 69-77 (1959).
In German.

Gas mixtures of CH_4 or C_2H_6 with NH_3 and H_2O yield organic compounds on exposure to the light from a quarz mercury vapour lamp. Reactions sensitized by Hg result in formation of aminoacids and lower fatty acids. Methane does not react under those conditions, but by irradiation with the resonance frequency of xenon glycine (established by paper chromatography) is formed. W.Good

541.14

3319 THE FORMATION OF MOLECULAR HYDROGEN THROUGH PHOTOLYSIS OF WATER VAPOR IN THE PRESENCE OF OXYGEN. C.A.Barth and H.E.Suess.
Z. Phys., Vol. 158, No. 1, 85-95 (1960).

A light source was constructed for the investigation of the photolysis of water vapour. A xenon discharge arc at a pressure of about 50 mm in a thin wall quartz tubing was used. Molecular hydrogen formed from water vapour in the presence of other gases was measured by employing tritium as a tracer. A vacuum system was constructed, allowing the separation of water vapour from hydrogen to better than 10^{-8} parts, and the counting of tritiated hydrogen in a Geiger counter. All measurements were carried out in a semi-quantitative way and it was found that the light source and the technique of measuring small amounts of free hydrogen by employing a tritium tracer can be used effectively for further studies of the reactions involving hydrogen and water. Self-decomposition of tritiated water vapour with and without addition of oxygen was measured and was found to be negligible under the particular conditions of the experiments over periods of several months. The photochemically induced exchange of tritium between tritiated water vapour and molecular hydrogen was studied. The quantum yield of this exchange was found to be under the conditions of the experiments of the order of one and probably slightly larger than one. It was possible to demonstrate the formation of free hydrogen from the photolysis of water vapour in the presence of oxygen and to measure these amounts as a function of oxygen pressure. The steady state concentrations of H_2 formed from water vapour by irradiation in the presence of oxygen under the influence of u.v. light were found to be smaller than expected. Photochemical oxidation of H_2 by O_2 under the particular conditions of the experiments and at pressures of about 1 mm was found to have a quantum yield of the order of magnitude of one.

541.14

3320 MATRIX ISOLATION STUDIES: INFRARED SPECTRA OF INTERMEDIATE SPECIES IN THE PHOTOLYSIS OF HYDRAZOIC ACID. II. M.Van Thiel and G.C.Pimentel.
J. chem Phys., Vol. 32, No. 1, 133-40 (Jan., 1960).

For Pt I, see Abstr. 3792 (1957). Further infrared studies of the photolysis of hydrazoic acid in solid nitrogen at 20°K confirm the spectroscopic detection of unusual molecular species. Neither hydrogen bonding nor tautomerism of HN_3 can account for the new bands detected. The two most prominent of these, at 1325 and 1290 cm^{-1}, are shifted by a factor near $\sqrt{2}$ when DN_3 is photolyzed. The data tend to confirm the presence of imine radical NH_2 but two alternate interpretations, diimide N_2H_2, or azide amine NH_2N_3, cannot be eliminated.

541.15

3321 REACTIONS INITIATED BY β DECAY OF TRITIUM. II. THE TRITIUM–ETHYLENE SYSTEM.
K.Yang and P.L.Gant.
J. chem. Phys., Vol. 31, No. 6, 1589-94 (Dec., 1959).

For Pt I, see Abstr. 745 (1960). Because of the β decay of tritium gas, $T_2 \rightarrow (He^3T)^+ + e$, the tritium–ethylene system undergoes reactions yielding various tritiated hydrocarbons. From the effects of three experimental variables (T_2 concentration, γ-irradiation, replacing T_2 by HT) on the rates of formation of tritiated compounds, two types of labelling process can be distinguished:

(a) Recoil labelling: $(He^3T)^+ + C_2H_4 + (e) \rightarrow$ Tritiated compounds,

(b) β labelling: $T_2 + C_2H_4 \rightarrow$ Tritiated compounds.

Formation of tritiated ethylene involved both processes; its rate was independent of temperature (25°C ↔ −78.5°C), and not affected by the addition of nitric oxide ($[NO]/[C_2H_4] \cong 0.05$). Tritiated ethane, propane, and n-butane were formed exclusively by the β-labelling process; the rate of formation of these compounds increased with decreasing temperature and nitric oxide almost completely eliminated their production. Probable mechanisms for the recoil and β-labelling processes are discussed.

541.15 : 532.7

DIFFUSION OF REACTION PRODUCTS FROM A RADIOACTIVE MONOLAYER. See Abstr. 2165

541.15

3322 COMPETITIVE REACTIONS IN THE IRRADIATION OF ANTHRACENE + CYCLOHEXANE SOLUTIONS.
A.Charlesby and D.G.Lloyd.
Proc. Roy. Soc. A, Vol. 249, 51-64 (Jan. 1, 1959).

Anthracene acts as a radical scavenger when present at low concentrations in irradiated hydrocarbons. A study has been made of the effect of radiation intensity and anthracene concentration on G(−A), the number of anthracene molecules lost per 100 eV of energy absorbed. A theoretical calculation is made of the dependence of G(−A) of radiation intensity I and anthracene concentration (A), assuming that radiation-induced radicals (R) are formed at random, and can either disappear by direct combination with one another, or with the anthracene to give RAR or RAAR bridges, or possibly some form of stabilized RA molecules. This theory is in good agreement with the experimental values of G(−A), measured at various low radiation intensities and anthracene concentrations. From the comparison estimates of the reactivity constants are derived. With very high intensity radiation quantitative agreement is less satisfactory, due to the non-steady conditions prevailing in a pulsed beam. The results obtained are compared with previous work on anthracene + hexane and iodine + cyclohexane mixtures, in which the effect of radiation intensity was not investigated. The results reported here are of interest to the study of reaction kinetics in irradiated organic systems.

541.15

3323 SOME SONOCHEMICAL REACTION YIELDS. A.Weissler.
J. Acoust. Soc. Amer., Vol. 32, No. 2, 283-4 (Feb., 1960).

Measurements of the yields of some sonochemical reactions show that the number of molecules produced per unit of energy absorbed in several hundred times smaller than the corresponding radiation chemistry (gamma-ray) yields. The ratio of the radical yield to the molecular yield in sonochemistry also is smaller than in gamma-irradiation reactions, but is approximately the same as in alpha-particle irradiations.

541.15 : 539.12

3324 FERRIC ION YIELDS IN FERROUS SULFATE SOLUTIONS IRRADIATED WITH LOW-ENERGY X-RAYS. L.H.Gevantman and J.F.Pestaner.
J. chem. Phys., Vol. 31, No. 4, 1140 (Oct., 1959).

$G(Fe^{3+})$ was found to be 14.4 ± 0.7 for a mean photon energy of 14 keV and 14.8 ± 0.7 for 35 keV. $FeSO_4$ solutions in 0.1N H_2SO_4 were irradiated in pre-irradiated thin leucite thimbles. The energies of the X-ray beam were determined from Al-absorption curves. Ionization measurements were done with a nylon thimble meter calibrated in the low energy region against a free air chamber. For calculation of the energy absorbed by the solution, W was taken to be 34 eV/ion pair. M.Ebert

DISPERSIONS . COLLOIDS
ADSORPTION

541.18

3325 ADSORPTION, DIFFUSION, AND EVAPORATION OF CARBON MONOXIDE ON TUNGSTEN. R.Klein.
J. chem. Phys., Vol. 31, No. 5, 1306-13 (Nov., 1959).

The surface migration, adsorption, and evaporation processes for carbon monoxide on tungsten were examined with a field-emission microscope operating at liquid helium temperature. Carbon monoxide shows three distinct temperature regions of surface behaviour. The first, a low temperature spreading from the Van der Waals layer, can be observed when several carbon monoxide layers are deposited on the "shadowed" portion of the tungsten point. After the low temperature spread, an emission pattern identical to that of clean tungsten is obtained, so that the lattice sites are completely occupied and the bonding is uniform. The second effect occurs above about 200° K and is characterized by development of graininess of the pattern. The third region can be observed when the point is shadowed with a monolayer or less. Surface migration from this chemisorbed layer takes place above about 625° K and has associated with it an activation energy of 36 kcal/mole. Desorption occurs in a temperature region commencing at about 1000° K with an activation energy of 52 kcal/mole. The pre-exponential factor of the Fowler–Nordheim expression was useful in following the desorption process, since it is essentially a measure of the low-work-function areas of the total emitting surface. In this way it was found that these areas follow first-order behaviour for the desorption process.

541.18

3326 THEORY OF ADSORPTION WAVE. RELATION BETWEEN THE EXHAUSTION OF THE CATALYST BED AND THE GAS VELOCITY AND BED THICKNESS. A.S.Predvoditelev.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 3, 602-5 (July 24, 1959).
In Russian.

See Katz, Advances in Catalysis and related subjects, Vol. 5, 177-216 (1953). The motion of a gas through a porous adsorbent of cylindrical shape is analysed, a few simplifying assumptions being made. The final equation obtained $T = m(d - d_k)/(W + mg_k)$, (where T is the time in which the front of wave produced has traversed the entire bed, m is the porosity of the bed, d and d_k are the thicknesses of the whole bed of the initial portion, respectively, W is the rate of filtration, and g_k is an integral having the dimension of velocity) is almost identical with that adduced by Katz and obtained from the ideas of Amundsen and Danby. The above formula is analysed. F.Lachman

541.18

3327 THEORY OF ADSORPTION WAVE. RELATION BETWEEN THE CONCENTRATION OF EXIT GAS AND THE TIME OF EXHAUSTION OF THE ADSORBENT. A.S.Predvoditelev.
Dokl. Akad. Nauk SSSR, Vol.127, No. 4, 825-7 (Aug. 1, 1959).
In Russian.

See preceding abstract. Derives the formula $y = 1/c_d = (1 - \alpha T)/c_0$, where c_d is the concentration of the reacting component in the exit gas (i.e. after the gas has passed through the adsorbing bed), c_0 - its initial concentration, α – reaction rate constant, and T – the time during which the adsorbing bed becomes exhausted. It is claimed that the author's theory is more correct than that of Danby [J. Chem. Soc., p. 918(1946)]. F.Lachman

541.18

3328 CALORIMETRIC HEAT OF ADSORPTION — NITROGEN ON TUNGSTEN. P.Kisliuk.
J. chem. Phys., Vol. 31, No. 6, 1605-11 (Dec., 1959).

The heat of adsorption of nitrogen on tungsten ribbon was measured calorimetrically. Up to a coverage of 2.5×10^{14} molecules/cm² the heat is sensibly constant at 4 eV/molecule. This is 20% less than the change in enthalpy of nitrogen adsorbed on similar ribbons determined from quasi-equilibrium adsorption isotherms. The coverage at which the heat departs from its constant value in the present room temperature experiments is twice that at which the change in enthalpy decreases sharply in the high-temperature equilibrium experiments. This is explained in terms of two types of adsorption site for nitrogen atoms on the exposed tungsten crystal planes. A pair consisting of one site of each type is occupied when a molecule is adsorbed at room temperature, but when the temperature is high enough to permit surface migration of nitrogen atoms, the more tightly binding sites are preferentially occupied. At high coverage, where the sticking probability falls to a low value, the calorimetric heat of adsorption depends critically on the microscopic details of the surface structure.

541.18

3329 THEORY OF ORTHO-PARA HYDROGEN SEPARATION BY ADSORPTION AT LOW TEMPERATURES, ISOTOPE SEPARATION. D.White and E.N.Lassettre.
J. chem. Phys., Vol. 32, No.1, 72-84 (Jan., 1960).

A theory of separation of ortho and para hydrogen, by adsorption at low temperatures, is developed by considering the energy levels of a three-dimensional hindered rotator. The Schroedinger equation and boundary conditions are identical with those for prolate spheroidal wave-functions and tables of the latter have been employed in calculating the energies as functions of the barrier height. Separation factors, at low surface coverage, have also been computed as a function of barrier height and these pass continuously from unity at zero barrier height over into the limiting separation factor for a two-dimensional rotator (in the adsorbed state) which was caused by Sandler in the approximate calculation of separation factors. The theory predicts that ortho hydrogen is more strongly adsorbed than para hydrogen at all barrier heights and that para deuterium is more strongly adsorbed than ortho deuterium. Moreover the ortho-para hydrogen separation factor is larger at all barrier heights than the para-ortho separation factor for deuterium. These results agree with the experiments of Cunningham, Chapin, and Johnston. Calculated and observed separation factors for hydrogen and deuterium (at low surface coverages) are not in accurate quantitative agreement, however this may be due to the fact that experimental separation factors for both isotopes were not determined under comparable conditions. Calculations have been made first by assuming that rotation and (centre of mass) vibration are separable. This model is then refined to take into account the interaction of rotation and vibration. The separation of the hydrogen-deuterium isotopes is also considered. Although the inclusion of interaction between vibration and rotation does not greatly change the ortho-para separation factors, this effect has a marked influence on the calculated isotope separation factors. It is of considerable interest that isotope separation factors are strongly dependent on the ortho-para composition of the isotope mixture, at least at low surface coverages, in the theory developed here.

541.18 : 537.2

MEASUREMENT OF CONTACT POTENTIAL VARIATIONS DURING GAS ADSORPTION AT METAL SURFACES. See Abstr. 2303

541.18

3330 ON THE CONDUCTIVITY OF DISPERSIONS. R.E.De La Rue and C.W.Tobias.

J. Electrochem. soc., Vol. 106, No. 9, 827-33 (Sept., 1959).

Experiments on suspensions of glass beads in electrolytes indicate that Bruggemann's approximation represents the dependence of effective conductance on volume fraction very satisfactorily when the dispersed phase contains a broad range of particle sizes. Data on narrow size ranges fall in between values predicted by the Maxwell and Bruggemann equations. These findings are consistent with the physical assumptions implicit in both theoretical developments.

541.18

3331 ON THE THEORY OF PARTICLE SIZE DISTRIBUTION IN AEROSOLS. H.Koppe.

Z. Phys., Vol.156, No.3, 211-16 (1959). In German.

In the formation of aerosols by condensation on nuclei from a supersaturated gas the influence of fluctuations in the distribution of the nuclei has been considered. With a random distribution of the nuclei the mass of the aerosol particles has been calculated to be proportional to the fourth root of the fraction of the total volume which is occupied by the nuclei. R.Schnurmann

541.18

3332 SMALL ANGLE X-RAY SCATTERING FROM ALUMINUM·HYDROXIDE GELS. II.

H.D.Bale and P.W.Schmidt.

J. chem. Phys., Vol. 31, No. 6, 1612-18 (Dec., 1959).

In a continuation of previously reported work [Bale and Schmidt, J. Phys. Chem., Vol. 62, No. 10, 1179-84 (Oct., 1958)] a further study of the physical structure of aluminium hydroxide gels prepared by different methods was carried out, using small angle X-ray scattering techniques. The effects of collimation corrections on some of the earlier data were calculated, and further experiments were conducted. Previously, the scattering from the fresh gels was found to be independent of the pH at which precipitation was carried out, and was shown to depend on the concentration and charge of the anion of the aluminium salt from which the gel was precipitated. The present study shows that the anion concentration during precipitation has a much greater effect on the scattering pattern than does the aluminium ion concentration. The scattering from gels prepared under conditions in which no ions were present was also studied. Scattering data from sols which are made from the gels indicate that the gels can be treated as assemblies of nearly independent particles. All fresh gels are amorphous. No ageing effects are observed in gels precipitated at pH 7 from aluminium sulphate. When gels are precipitated at pH 7 from aluminium nitrate, thin boehmite platelets are first formed. After further ageing, platelets of gibbsite appear. Values of platelet thickness were determined. When gels are precipitated from aluminium nitrate and aged at high pH, large bayerite crystals are formed. When the gels are dried, a marked effect is observed on the scattering patterns for the fresh gels, while little change is observed in the scattering from the aged gels. According to the usual interpretation of scattering data, the fresh gels contain some particles or aggregates at least as large as a few hundred Angstroms. Also, a considerable number of the particles must have some dimensions of the order of 25 A or less. The relative importance of the large and small structures in the fresh gels varies with the conditions of preparation. The fresh gel results can be interpreted in terms of a distribution of particles or in terms of an aggregation of small particles.

541.18

3333 STREAMING BIREFRINGENCE AND OPTICAL RELAXATION TIME OF VANADIUM PENTOXIDE SOLS.

W.T.Foreman.

J. chem. Phys., Vol. 32, No. 1, 277-84 (Jan., 1960).

Maxwell constant and optical relaxation time was studied for V_2O_5 sols having concentrations which range from 0.01 to 0.1 volume percent using mercury green, 5461 A, and mercury red light, 6000 to 6800 A. These quantities were measured in a device which sheared the sols between two coaxial discs, that is, in a direction which corresponds to the radial one in a Couette device. The Maxwell constant ranged from about 1.5×10^{-3} to about 4.5×10^{-6} cm^2/dyne for freshly made sols and from about 8.0×10^{-3} to 2.9×10^{-5} cm^2/dyne for the same sols when they were 29 days old. It is shown that the Maxwell constant for these sols was an exponential function of concentration and that the optical relaxation time and Maxwell constant could be related for them. Because the Maxwell constant is an exponential function of sol concentration, it is suggested that the expression for the rotary diffusion constant of an infinitely dilute sol of rod-shaped particles can be made applicable to more concentrated sols by multiplying it by the term $(e^{sC}-1)/sC$, where C is concentration and s is the slope of the curve relating sol concentration to Maxwell constant, to account for the change in particle interaction with change in sol concentration. The viscosity and spectral transmission of these sols were also checked. It was found that the viscosity ranged from 1.0 cp for the most dilute sol to about 1.25 cp for the sol of concentration 0.1 volume percent. These sols were found to have a transmission which peaked at about 6800 A and dropped rapidly on either side of this value.

PHYSICAL METHODS OF CHEMICAL ANALYSIS

545

3334 NONEQUILIBRIUM KINETICS AND CHROMATOGRAPHY. J.C.Giddings.

J. chem. Phys., Vol. 31, No. 6, 1462-7 (Dec., 1959).

Reports a study of the complex kinetic processes which determine the structure of component zones in chromatography. The problem is approached by assuming that the various steps are proceeding near equilibrium. In order to facilitate the analysis an approximation is made in which each derivative of a concentration is replaced by the derivative of the equilibrium concentration. The latter derivatives are evaluated in terms of the concentration profile. This yields a set of linear algebraic equations from which an equilibrium departure term, ϵ, can be found for each species. The diffusion of the zone is then obtained as a function of the various ϵ's. The simplicity introduced by this method allows one to obtain the zone diffusion term for complex kinetics in contrast to the rigorous theories where only the simplest kinetic schemes have been treated. The results for a simple kinetic example are the same, however, as obtained in the limit of large times by the rigorous methods. The validity of the assumptions made is established independently of this comparison. Various applications of the method are discussed which extend beyond the range of chromatographic analysis.

545

3335 DETERMINATION OF URANIUM CONTENT IN RADIOACTIVE MINERALS BY AUTORADIOGRAPHY.

G.V.Umamaheswararao and R.Krishnaswamy.

Proc. Indian Acad. Sci. A, Vol. 44, No. 3, 144-51 (Sept., 1956).

Nuclear track plates serve as a rapid and cheap tool in the identification and estimation of radioactive minerals in ore specimens, microsections and sand-grains. A method of estimation of the uranium content of the minerals from photographic density was studied. This method avoids the tedious process of counting large number of tracks recorded in the nuclear emulsion by the radioactive minerals. The effects of (1) uranium content of the mineral specimens, (2) duration of exposure of the plate to the mineral specimens, (3) period of development of the plates and (4) temperature of the developer bath, on photographic density were studied.

545

3336 THE ROLE OF EMISSION SPECTROSCOPY IN THE NUCLEAR FIELD. G.Rossi.

Energia nucleare, Vol. 6, No. 11, 696-701 (Nov., 1959). In Italian.

The usefulness and the possiblity of spectral methods as applied to analytical chemistry, isotope determinations, and high temperature measurements are reviewed. Results of typical applications are also reported.

545

3337 ON THE INFRARED SPECTROSCOPIC DETERMINATION OF QUARTZ IN MINE DUSTS. M.Gade and K.F.Luft.

Naturwissenschaften, Vol. 46, No. 9, 315-16 (1959). In German.

Specimens heated to 700° C and measured by the KBr pressed disc technique show only an absorption band characteristic of quartz at about 12.5μ; the precision is thought to be ± 1% of quartz.

G.F.Lothian

545

3338 LAUE SPECTROMETER FOR MULTICHANNEL X-RAY SPECTROCHEMICAL ANALYSIS.

J.Ladell and N.Spielberg.

Rev. sci. Instrum., Vol. 31, No. 1, 23-9 (Jan., 1960).

A method for making use of the Laue diffraction technique rather than the Bragg symmetric technique in the design of multichannel X-ray spectrochemical analysis instruments is described. The method uses only one analysing crystal, but with individual detectors for simultaneous registration of the relative amounts of the elements in the sample to be analysed. Thus a compact instrument with no moving parts, which may often be designed so as to reduce spectral interferences, is possible. The method is compared with other well-known methods and some experimental tests of the principle are described.

GEOPHYSICS

550.3

3339 ALEXANDER VON HUMBOLDT AND THE ORGANIZATION OF INTERNATIONAL COLLABORATION IN GEOPHYSICAL RESEARCH. L.Kellner.

Contemporary Physics, Vol. 1, No. 1, 35-48 (Oct., 1959).

The history of research into geomagnetic phenomena in the first half of the nineteenth century is given in outline. An account is given of the role played by Alexander von Humboldt in the organization of international collaboration in this field.

550.3

3340 RESULTS OF THE MEASUREMENT OF THE MAGNETIC FIELD OF THE EARTH BY A SPACE ROCKET. S.Sh.Dolginov and N.V.Pushkov.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 1, 77-80 (Nov. 1, 1959).

In Russian.

A three-component magnetometer carried by the rocket launched on January 2, 1959, measured the strength of the earth's magnetic field at various distances from the earth. The range of measurement was from −0.03 to 0.03 Oe; effects of zero creep ($< 2 \times 10^{-4}$ Oe), and ferromagnetic parts of the rocket ($< 7 \times 10^{-4}$ Oe), were allowed for. The results are exhibited as graphs. It was found that the measured field fell short of the field calculated by spherical harmonic analysis on the assumption that it was due to sources inside the earth. This applies to fields at distances extending from about two to five times the earth's radius. The excess of theoretical over measured field showed a maximum of 8×10^{-3} Oe at about $2.05 \times \times 10^4$ km, a minimum at 2.25×10^4 km, and a second smaller maximum around 2.35×10^4 km. A similar set of smaller maxima and minima occurred at 3.2 to 3.6×10^4 km. It was deduced that over distances two to five times the earth's radius, the magnetic field was produced by external as well as internal sources. The external sources are currents in the corpuscular zone, most probably due to the drift of charged particles in the non-uniform field of the earth, and are probably responsible for the non-coincidence of the so-called geomagnetic and effective equators. The establishment of quantitative links between observed magnetic effects and the parameters of the external corpuscular zone is a very important theoretical and experimental problem. See Abstr. 6642 (1955) and 4545 (1958). N.Davy

550.9

3341 RADIOISOTOPES IN THE DATING OF GEOLOGICAL AND ARCHAEOLOGICAL EVENTS.

B.J.Giletti and R.S.J.Lambert.

Research, Vol. 12, No. 10-11, 368-73 (Oct.-Nov., 1959).

Methods for determining the age of geological and archaeological events by the use of radioisotopes is reviewed. The C^{14} method is described together with its application to events up to 70 000 years old. The U–Th–Pb, K^{40}–A^{40}, and Rb^{87}–Sr^{87} decay schemes are discussed in terms of their application to dating geological events which may be millions or even thousands of millions of years old.

ATMOSPHERE . IONOSPHERE

(Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

551.5 : 525

3342 MASS-SPECTROMETRIC MEASUREMENTS OF THE IONIC STATE OF THE UPPER ATMOSPHERE BY THE THIRD ARTIFICIAL SPUTNIK. V.G.Istomin.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 1, 81-4 (Nov. 1, 1959).

In Russian.

During the period May 15-25, 1958, about 15 000 mass spectra of the positive ions in the ionosphere were obtained by the third sputnik, at heights of 225-980 km. The measurements were all carried out in the northern hemisphere, in latitudes 27°-65°, mainly between 7-10 a.m., Moscow time. On account of the 2-4 volts negative potential of the sputnik, the sensitivity was greater but the resolution less than in terrestrial measurements. After distinguishing false harmonic peaks from the true fundamental peaks of the spectrograms, it was found that ionised atoms of oxygen O^+ were present at all levels. Others present at some levels were ions of atomic nitrogen, N^+, an isotope of oxygen $(O^{18})^+$, nitric oxide NO^+, molecular oxygen O_2^+ and molecular nitrogen N_2^+. Graphs showing the relative peak intensities of the other ions with respect to those of O^+, at various heights and latitudes are shown, and general deductions are made. All peaks have maximum intensities at the perigee position of the sputnik, and fall off fairly quickly as the height decreases. The maximum height at which each kind of ion was detected is stated approximately. Above 500 km. only ions of atomic oxygen and atomic nitrogen were found. (See Abstr. 5544 of 1958). [In the original paper the legends of figs 4A and 4B have been interchanged]. N.Davy

551.5 : 621.391.812.5

3343 GEOPHYSICAL EFFECTS OF HIGH-ALTITUDE NUCLEAR EXPLOSIONS.

T.Obayashi, S.C.Coroniti and E.T.Pierce.

Nature (London), Vol.183, 1476-8 (May 23, 1959).

The time of the Aug. 1, 1958, explosion on Johnston Island coincided with a loss of signal on three transmitters (15 Mc/s, Honolulu; 10 Mc/s, Honolulu; 13.75 Mc/s, San Francisco) as received at Hiraiso, Japan, although the path from San Francisco to Japan is ~ 3600 km from Johnston Island (and more remote from the geomagnetic conjugate of Johnston). The explosion of Aug. 12, 1958, coincided with a pronounced effect for the Honolulu transmitter on 15 Mc/s (a less marked effect for the other Honolulu transmitter, and no significant effect for the San Francisco station). Besides, an enhancement of the level of atmospherics on 28 kc/s was detected at the time of explosion. These effects are similar to those caused in the ionosphere by a solar flare. F.Lachman

551.5 : 621.391.812.63

3344 EFFECT OF SMALL IRREGULARITIES ON THE CONSTITUTIVE RELATIONS FOR THE IONOSPHERE.

K.G.Budden.

J. Res. Nat. Bur. Stand., Vol. 63D, No. 2, 135-49 (Sept.-Oct., 1959).

Irregularities in the ionosphere which are small compared with one wavelength may modify the constitutive relations, and hence, may affect the refractive indices for electro-magnetic waves. The modifications are in some ways similar to those which would be introduced into the Appleton–Hartree formula by a Lorentz force. The theory is given first for the case when the irregularities extend only in one dimension, and it is found that even in a loss-free medium the refractive index now has an imaginary part which

might be associated with loss of energy from the wave by scattering. The theory for three-dimensional irregularities is then discussed but is more difficult, and a method of successive approximations is used. The results indicate that small irregularities may play an important part in the propagation of very-low-frequency radio waves in the ionosphere. In particular, they may explain why "whistlers" are observed only on comparatively rare occasions.

551.5 : 621.391.812.63

3345 IONOSPHERIC INVESTIGATIONS USING THE SWEEP-FREQUENCY PULSE TECHNIQUE AT OBLIQUE INCIDENCE. V.Agy and K.Davies.
J. Res. Nat. Bur. Stand., Vol. 63D, No. 2, 151-74 (Sept.-Oct., 1959).

Describes the present state of oblique-incidence investigations of the ionosphere, using the sweep-frequency pulse technique, with special reference to the work carried out at the National Bureau of Standards. After a short review of the published literature, oblique-incidence sweeps are presented showing the diurnal and seasonal variations on two east–west paths of lengths 1150 km and 2370 km. The discrepancies between observed and calculated m.u.f's. are presented for both paths and then various phenomena of interest are shown. Finally, the above phenomena are discussed in the light of existing knowledge and theory and, in particular, it is shown that the discrepancies between observed and calculated m.u.f's. are unlikely to be caused by magneto-ionic deviation of the ray.

551.5

3346 VARIATION WITH LUNAR PHASE OF MIDDAY CRITICAL FREQUENCIES AND HEIGHTS OF THE F2 LAYER OVER AHMEDABAD AND OTHER LOW LATITUDE STATIONS.
K.M.Kotadia and K.R.Ramanathan.
Proc. Indian Acad. Sci. A, Vol.43, No.6, 394-9 (June, 1956).

The paper contains an analysis of the variation of the midday values of foF_2, $h'F_2$ and hpF_2 with lunar phase at Ahmedabad during the years 1954 and 1955 and of foF_2 alone at Bombay, Madras and Tiruchirapalli during 1954. It is found that while the semidiurnal lunar tidal variations at Ahmedabad and Bombay agree in phase with those observed at middle latitudes, the phase reverses in direction between Bombay and Madras. The results are compared with those relating to Huancayo and Singapore.

551.5

3347 MEASUREMENT OF IONOSPHERIC DRIFT AT AHMEDABAD FROM FADING PATTERNS OF REFLECTIONS ON 2.6 AND 4.0 Mc/s (23° 02' N; 72° 38' E). R.Sethuraman.
Proc. Indian Acad. Sci. A, Vol. 48, No. 2, 84-100 (Aug., 1958).

Results of observations of ionospheric drift carried out over a period of 15 months at Ahmedabad on 2.6 Mc/s and 4.0 Mc/s by the spaced aerial method are presented. The prevailing day-time drift was towards north-west in autumn and winter. In summer, and to a less marked degree in spring and autumn, the morning direction of drift was towards east or south-east. The evening direction was always towards north-west. During the night hours, the directions of drift were more spreadout, but the most frequent directions were still towards north-west and south-east. The speeds lay mostly in the range 40-100 m/s and the mean speed was larger in winter than in summer. The Ahmedabad results are compared with those at other places.

551.5 : 621.391.812.63 : 621.396.946

3348 A METHOD FOR MEASURING LOCAL ELECTRON DENSITY FROM AN ARTIFICIAL SATELLITE.
L.R.O.Storey.
J. Res. Nat. Bur. Stand., Vol. 63D, No. 3, 325-40 (Nov.-Dec., 1959).

A method is proposed for measuring the electron density at known points in the outer ionosphere, by the use of v.l.f. receiving equipment in an artificial satellite, in conjunction with a v.l.f. transmitter on the ground. The transmitter would radiate continuous waves, which would be propagated through the ionosphere in the "whistler" mode. The basis of the method is a measurement of the local wave-admittance of the medium, by comparison of the signals received on an electric dipole and on a loop. A further proposal is made for an integrated v.l.f. satellite experiment, in which several different types of observation would be made simultaneously.

551.5

3349 DETERMINATION OF THE NUMBER OF COLLISIONS IN THE IONOSPHERE. O.M.Ataev.
Radiotekhnika i Elektronika, Vol. 4, No. 9, 1439-43 (Sept., 1959).
In Russian.

Describes short-wave (1.5 to 10 Mc/s) absorption measurements carried out in 1950-51 using vertical sounding for determining the effective number of collisions ν_{eff} of electrons with neutral molecules and ions in the maximum ionization layers D, E, F_2. The values obtained for ν_{eff} for these layers are respectively $(1\text{-}2.1) \times 10^7$, 5.5×10^6-1.4×10^6, and 4×10^6-1.6×10^7 sec^{-1}.

D.E.Brown

551.5

3350 ELECTRON COLLISION FREQUENCIES IN NITROGEN AND IN THE LOWER IONOSPHERE.
A.V.Phelps and J.L.Pack.
Phys. Rev. Letters, Vol.3, No.7, 340-2 (Oct. 1, 1959).

Results are given for measurements of the electron collision frequencies for thermal electrons in nitrogen using an improved version of the electron drift velocity tube. These are shown to agree satisfactorily with collision frequency measurements for the D layer of the ionosphere, re-evaluated by the authors from recent rocket data.

G.M.Brown

551.5 : 621.391.812.63

3351 STRATIFICATION IN THE LOWER IONOSPHERE.
C.Ellyett and J.M.Watts.
J. Res. Nat. Bur. Stand., Vol. 63 D, No. 2, 117-34 (Sept.-Oct., 1959).

A survey of the evidence for stratification in the ionosphere below 100 km is given, covering radio and optical observations, and rocket measurements. The conclusion is reached that one stratum at about 85 km is observed consistently, and that other fine structure exists but has no long-time constancy of height or pattern. There is no series of preferred heights below 100 km. Explanations are considered which may account for the observations, and the testing of radio methods of exploration in conjunction with rocket measurements is advocated in order to develop the most practicable means of obtaining accurate electron density v. height profiles on a synoptic basis. A bibliography of approximately 150 references is given.

551.5

3352 FERMI ACCELERATION OF ELECTRONS IN THE OUTER VAN ALLEN BELT. J.A.Crawford.
Phys. Rev. Letters, Vol. 3, No. 7, 316-18 (Oct. 1, 1959).

A mechanism is proposed whereby the radiation in the outer Van Allen belt is not destroyed at times of violent disturbance associated with the influx of a solar wind from a flare. During a storm, closed magnetic loops will be formed in the region where the energy densities of the storm and the earth's field are equal, and the electrons trapped in these loops will be able to undergo a Fermi acceleration to very high energies without their being absorbed in the earth's atmosphere. The mechanism is investigated quantitatively.

G.M.Brown

551.5

3353 THE UPPER BOUNDARY OF THE VAN ALLEN RADIATION BELTS. C.W.Snyder.
Nature (London), Vol. 184, 439-40 (Aug. 8, 1959).

Discrepancies between the results obtained from the flights of Pioneer III and Pioneer IV are resolved. Both flights indicate an upper boundary of the radiation belts at about 10 earth radii, and this figure agrees with that obtained by the Russian cosmic rocket Mechta.

H.J.A.Chivers

551.5

3354 ON THE STRUCTURE OF ELECTRO-CONVECTIVE EDDIES. J.Josephson.
C.R. Acad. Sci. (Paris), Vol. 249, No. 8, 876-7 (Aug. 24, 1959).
In French.

Eddies which might throw light on the formation of typhoons and tornadoes were set up experimentally in air within an open hollow metal cylinder of diameter 30 cm and height 50 cm, maintained at a high negative electrostatic potential. Rotational oscillations in the air, initiated by means of a fine wire carrying low tension alternating current, were maintained after the wire had been removed, by means of a suitable injection of positive electrostatic charges. Visible light and noise resembling thunder were emitted.

J.G.Oldroyd

551.5 : 621.391.812.61

3355 VERY-LOW-FREQUENCY RADIATION SPECTRA OF LIGHTNING DISCHARGES. W.L.Taylor and A.G.Jean.
J. Res. Nat. Bur. Stand., Vol. 63D, No. 2, 199-204 (Sept.-Oct., 1959).

Spectral analyses are given of the groundwave portion of 33

sferic waveforms recorded from cloud-to-ground lightning discharges which occurred at distances ranging between about 150 and 600 km from Boulder, Colo. Frequencies of peak energy lie between 5 and 20 kc/s, which agree favorably with other published results. The average value of energy calculated from the groundwave pulses was found to be 26 600 J, which is lower than values derived from other experiments. Various parameters, such as the peak amplitude and duration of the first half-cycle, are related to the radiated energy of the stroke.

551.5 : 621.391.822

3356 NOISE TRAINS.
N.C.Gerson and W.H.Gossard.
Canad. J. Phys., Vol. 37, No. 9, 1061-2 (Sept., 1959).

Some preliminary results of a new kind of noise burst, styled a "sweeper", which exhibits a frequency sweep through the 500 kc/s bandwidth of an atmospheric noise spectrograph covering the frequency range 1-30 Mc/s. The drift is usually from high to low frequencies, and may occur in less than 0.1 sec. Possible origins are discussed. G.M.Brown

551.5 : 621.391.812.62

3357 RADIO-REFRACTIVE-INDEX CLIMATE NEAR THE GROUND. B.R.Bean and J.D.Horn.
J. Res. Nat. Bur. Stand., Vol. 63D, No. 3, 259-71 (Nov.-Dec., 1959).

The radio refractive index of air is a function of atmospheric pressure, temperature, and humidity and is found to vary in a systematic fashion with climate. It was found that the surface value of the refractive index may be estimated four to five times more accurately from charts of reduced-to-sea-level values than from similar sized charts of surface index. Worldwide maps of 5-year means of this reduced value are presented for the months of February and August, for the minimum monthly mean value of the year and for the range of monthly mean values. Year-to-year variation of monthly means is also considered. Applications of these data to the prediction of radio field strengths indicate a possible 30 dB difference in median level of identically equipped tropospheric communications systems due to climate alone.

551.5

3358 A MONOCHROMATIC LOW-LATITUDE AURORA.
F.E.Roach and E.Marovich.
J. Res. Nat. Bur. Stand., Vol. 63 D, No. 3, 297-301 (Nov.-Dec., 1959).

A monochromatic (6 300 A) auroral arc occurred over Colorado on September 29/30, 1957. It seems to have been a continuation of a similar arc observed at Haute Provence, France, on the same night. Its intensity decreased during the night from about 7 000 rayleighs to 2 000 rayleighs compared with a normal zenith intensity of 100 to 200 rayleighs. It was relatively fixed (geographically) during the night, south of and apparently independent of a visual aurora that was active to the north from 0100 to 0400 m.s.t. The magnetic dipole lines of force from the arc extend out into space between the two Van Allen radiation belts. It is speculated that the arc may be associated with one of the belts.

551.5 : 537.52

AURORAL AFTERGLOW. LABORATORY SCALE STUDY.
See Abstr. 2346-7

551.5

3359 EXCITATION MECHANISMS OF THE OXYGEN 5577 EMISSION IN THE UPPER ATMOSPHERE.
E.Tandberg-Hanssen and F.E.Roach.
J. Res. Nat Bur. Stand., Vol. 63D, No. 3, 319-24 (Nov.-Dec., 1959).

Possible excitation mechanisms for the green 5577 emission are considered in the light of recent data on the dynamics of the upper atmosphere. Photochemical reactions as affected by mass motions as well as excitation directly due to the mass motions are analysed. It is concluded that either or both mechanisms could probably account for the observed emission.

551.5

3360 THE OPTICAL STATE OF THE [EARTH'S] ATMOSPHERE UNDER TWILIGHT ILLUMINATION.
V.G.Fesenkov.
Astron. Zh., Vol. 36, No. 2, 201-7 (1959). In Russian.

A method is given which permits determination of the trajectories of solar rays passing through the atmosphere at different heights above sea level and the corresponding refraction and extinction. The method is employed to construct numerical tables which can be used in the theory of twilight phenomena, the photometric theory of lunar eclipses and in other related problems. A.Tybulewicz

551.5

3361 THE CRYSTALLIZATION OF SUPER-COOLED WATER CLOUDS BY FREEZING OF DROPS.
A.G.Kolesnikov and V.I.Belyaev.
Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 5, 636-42. In Russian. English summary: PB 141042T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

In seeding experiments the crystallization takes place when crystals form on sublimation nuclei, but in natural processes it is more likely to occur by freezing of the water droplets. The cloud is assumed to be homogeneous, and at the start consists of water vapour and drops in dynamic equilibrium. At a certain time, because of change of temperature, etc., metastability occurs and this moment is taken as the onset of crystallization. Since the saturation vapour pressure is lower over ice than water, the ice crystals grow at the expense of the water vapour and the process continues until the whole cloud is frozen. The theory of the process is treated mathematically, using Maxwell's diffusion equation. Expressions are derived for the overall number of drops and crystals in the cloud at any time and their densities of distribution. S.Weintroub

551.5 : 539.16

DISTRIBUTION OF ACTIVITY IN RADIOACTIVE RESIDUES FROM ATMOSPHERIC PRECIPITATES. See Abstr. 2630

BIOPHYSICS · PHYSIOLOGICAL PHYSICS

574 : 621.389

3362 PULSE-HEIGHT ANALYZER FOR NEURO-PHYSIOLOGICAL APPLICATIONS. R.M.Littauer and C.Walcott.
Rev. sci. Instrum., Vol. 30, No. 12, 1102-6 (Dec., 1959).

A five-channel differential pulse-height analyser is described, designed specifically for the observation of action potentials in nerve fibres. By measurement of the pulse amplitudes, it is possible to follow the activity of one or more single nerve fibres continuously.

Hearing . Speech

612.8

3363 SPEECH TRANSMISSION WITH THE EAR MICROPHONE. J.Naujoks.
Nachrichtentech. Z.(N.T.Z.). Vol. 12, No. 8, 400-2 (Aug., 1959). In German.

Reference is made to a paper "On the ear microphone" (Physikalische Verhandlung der Nordwestdeutschen Physikalische Gesellschaft, Vol. 9, No. 2, 26, 1958). This microphone operates in the cavity of the external ear and consequently tends to increase the "signal to noise" ratio by excluding disturbing sounds. In the present paper a comparison is made between four types of microphone in syllable intelligibility (S.I.) measurements. The microphones tested were (1) pressure-gradient microphone, (2) crystal larynx-microphone, (3) ear microphone (single channel transmission) and (4) ear microphone (stereophonic transmission). The S.I. measurements indicate approximately 85% for (1), 70% for (2) and 60% for (3) and (4). A.B.Wood

612.8

3364 THE EXCITATION OF HEARING BY SUSTAINED SOUNDS AND BY SHORT IMPULSES. R.Oetinger.
Nachrichtentech. Z. (N.T.Z.), Vol. 12, No. 8, 391-9 (Aug., 1959). In German.

Describes an investigation of the mechanical vibrations set up in the inner ear, i.e. the Basilar membrane and the organ of Corti, by sounds of varying frequency, amplitude and duration. In the first part of the investigation a study is made of the excitation of Corti's organ by sounds of different frequency (within the audible range) and bandwidths. This is followed by a section dealing with the equivalent duration of excitation of Corti's organ by a single pressure impulse. A.B.Wood

612.8

3365 MASKED THRESHOLDS FOR OCTAVE BAND NOISE. J.L.Fozard, W.E.Bacon and A.M.Small, Jr.
J. Acoust. Soc. Amer., Vol. 31, No. 12, 1681-2 (Dec., 1959).

Preliminary experiments on the masking of octave bands of noise (127-255 c/s and 1020-2040 c/s) by wide-band noise (50-9000 c/s) at sensation levels 10, 20 and 50 dB, are reported. The lower band was more masked by the wide band noise than the higher band. The effects of the level of the masking noise on the masked threshold were in the direction predicted by previous work. H.D.Parbrook

612.8

3366 AUDIBILITY OF SWITCHING TRANSIENTS. H.N.Wright.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 138 (Jan., 1960).

Experimental evidence is presented which is consistent with the hypothesis that the audibility of switching transients depends on the amount of suprathreshold energy integrated by the ear over the spectrum of the transient state. H.D.Parbrook

612.8

3367 TEMPORARY THRESHOLD SHIFT IN A CHANGING NOISE LEVEL. W.D.Ward, A.Glorig and W.Selters.
J. Acoust. Soc. Amer., Vol. 32, No. 2, 235-7 (Feb., 1960).

When an individual is exposed first to a high-level noise H for a time T and then to one of lower level L for time t, the temporary threshold shift (T.T.S.) is equal to the numerical sum of (1) the T.T.S. in dB that would be produced by level L acting over a period of time T + t, and (2) the T.T.S. in dB that would remain after t min of recovery in quiet from $T.T.S_D$, where $T.T.S_D$ is the difference between (a) the T.T.S. at the end of the T-min exposure to H and (b) the T.T.S. that would have been produced by T min of exposure to L. It appears that this result rules out any simple explanation of T.T.S.

612.8

3368 LATERALIZATION OF HIGH-FREQUENCY TONES. A.W.Mills.
J. Acoust. Soc. Amer., Vol.32, No.1, 132-4 (Jan., 1960).

Thresholds for interaural difference between the intensities of dichotic tone pulses were measured on five subjects by the method of constant stimuli, at frequencies between 250 and 10 000 c/s and at a sensation level of 50 dB. The just noticeable dichotic differences in intensity is about 1 dB at 1000 c/s, a little smaller at lower frequencies, and still smaller (0.5 dB) at higher frequencies. This function is compared with the interaural difference in intensity produced by the just noticeable deviation from the median plane of an actual source of tone pulses. At low frequencies, where phase or time differences are generally considered more important that intensity differences for auditory localization, these two functions differ greatly. At frequencies between 1500 and 6000 c/s the threshold for a dichotic difference in intensity matches the interaural difference in intensity that is produced by the just noticeable deviation from the median plane of an actual source. The relation between the discrimination of dichotic differences in phase and intensity and the discrimination of actual direction is shown in a graphical summary.

612.8

3369 SHEARING MOTION IN SCALA MEDIA OF COCHLEAR MODELS. J.Tonndorf.
J. Acoust. Soc. Amer., Vol. 32, No. 2, 238-44 (Feb., 1960).

Bekesy first reported (Abstr. 6345-6 of 1953) the occurrence of shearing motion within the cochlear duct and furthermore the notion that it is this mode of motion which constitutes the adequate stimulus for the hair cells. There were two modes of shear motion: radially directed in the region proximal to the place of maximal amplitude of the travelling-wave pattern, and longitudinally directed distal to that point. This phenomenon was studied in cochlear models. The envelopes over both modes of shear motion were found to be much smaller than that over the travelling wave pattern. A simple explanation presented itself. The direction of the shearing motion in each domain coincides with the dominant curvature produced by the travelling-waves in that section of the cochlear duct. Earlier, it had been shown that under the effect of Bekesy's eddies, i.e. at higher driving amplitudes, the displacement pattern of the cochlear partition becomes asymmetrical. The asymmetry produces a d.c. shift in both domains of shear motion: in an outward direction within the domain of radial shear and in an apical direction within the domain of longitudinal shear. However, when the round window was driven, both directions of the d.c. components were reversed. The latter finding aided in establishing the causal relationship mentioned in the foregoing.

612.8

3370 VARIATION IN EAR PROTECTOR ATTENUATION AS MEASURED BY DIFFERENT METHODS.
L.Weinreb and M.L.Touger.
J. Acoust. Soc. Amer., Vol. 32, No. 2, 245-9 (Feb., 1960).

The A.S.A. standard "Method for the measurement of the real-ear attenuation of ear protectors at threshold"—Z24.22/406, specifies the use of threshold shift techniques. It was observed during extensive evaluation of developmental ear protective devices over the past ten years that large differences in attenuation are obtained when using different attenuation measuring techniques. In addition, these differences vary for the different types of protectors being studied. In the study reported herein, four grossly different types of protectors were measured. These protectors differ in volume under the protector and in the principal sound transmission path at low frequencies. The test subjects and room environment were the same for all the measurements. The results indicate that threshold shift measurements yield higher values of attenuation than either loudness balance or the microphone method. However, the results

vary widely for different types of protectors as a function of frequency. Differences of 3 dB or greater between protector types as measured by any of the three measuring techniques were found to be significant at the 95% confidence level using four subjects and three replications.

612.8

3371 IMPROVED TECHNIQUE FOR DETAILED MEASUREMENTS OF THE MIDDLE EAR IMPEDANCE.

A.R.Møller.

J. Acoust. Soc. Amer., Vol. 32, No. 2, 250-7 (Feb., 1960).

An apparatus is described for measurement of the acoustic impedance of the middle ear at the tympanic membrane. The measuring technique offers a possibility of studying the fine structure of the middle ear impedance, which contained not a single but several resonance peaks. The method employed makes use of a constant current sound source mechanically fixed to a microphone probe indicator. Both the sound generator and the sound receiver microphone are coupled to a tube which is inserted into the ear. This unit can be fixed directly to the subject's head, thereby eliminating the effect of the subject's movements on the measurements. The results of measurements on eight normal subjects are presented, in part as impedance, in part as admittance. The admittance is measured for 50 c/s intervals in the frequency range from 200 to 2000 c/s. The individual spread of data proved to be very great and appreciably greater than the difference between the two ears of a single individual.

Vision

612.8

3372 COLOR VISION AND THE NATURAL IMAGE. I.

E.H.Land.

Proc. Nat. Acad. Sci. U.S.A., Vol. 45, No. 1, 115-29 (Jan., 1959).

A pair of black-and-white positive transparencies were obtained by photographing a coloured scene with a split-beam camera so that they were taken at the same time from the same viewpoint, through the same lens, but through red and green filters, respectively. The two records were projected by a double-lens white-light projector on to a screen, in complete register; paired polarizers being used to adjust the intensity of each beam. A series of 16 step-by-step experiments showed that a fully coloured image results on the screen if the "red" and "green" transparencies were respectively illuminated by a longer and a shorter wavelength, or by white and a short wavelength, or by a long wavelength and white; colour reversed being obtained by reversing these pairs. These experiments also showed that room illumination, field of view, or preknowledge of colour did not affect the image, and that the relative intensities of the component beams could be varied over a very wide range with little effect on most of the colours present. A further five experiments investigated the colour limitations of the images in terms of the illuminating beam wavelengths. It was also observed that the image projected must contain an element of raddomness, or only the expected classical colour mixing occured. See following abstract.

612.8

3373 COLOR VISION AND THE NATURAL IMAGE. II.

E.H.Land.

Proc. Nat. Acad. Sci. U.S.A., Vol. 45, No. 4, 636-44 (April, 1959).

For Pt I see preceding abstract. Referring to the experiments of Pt I, a new coordinate system to describe the colours obtained in the images is proposed. It was noted that the colours derived from two primaries did not depend on their wavelengths, nor on their relative intensities, therefore it was suggested that the colour seen at a particular point in the image is determined by the intensity of light present for each of the beams relative to the intensity that would occur without the transparency present. An experimental plot of percentage of available long wavelength stimulus against percentage of available shortwave stimulus, using a specially-designed dual monochromator for illuminating the superimposed images, produced a "colour map" containing the loci of all colours. This map is divided by a 45° line through the one hundred percent point, one half containing colours in the normal image, the other those of the colour-reversed image, and can be used to predict the defects in colour of images formed in this way. Tables are given of experimental results using the pairs of wavelengths 5600 and 6150 A, 4500 and 5750 A, 5750 and 5950 A, 4100 and 4600 A.

612.8 : 77 : 621.397

3374 EXPERIMENTS IN COLOR VISION.

E.H.Land.

Sci. Amer., Vol. 200, No. 5, 84-99 (May, 1959).

A description of Land's experiments (see preceding abstracts) which showed that if the two transparencies, obtained by photographing a scene first through one filter then through another different filter, are projected in register by beams of the colour corresponding to the respective filters, then the eye interprets the field of view as being in the same full colour as the original (although colour saturation is determined by the spectral closeness of the beams). Details of further experiments using such transparencies with pairs of monochromatic beams or with a white light and a monochromatic beam are given, yielding a "colour map" predicting the limitations in faithfulness of colour experienced by the eye. It is further shown (and colour photographs are included) that with white light as one of the sources, normal colour photography of the projected scene is possible. The importance of the work to colour photography and colour television technology is apparent. (See also following abstract).

612.8

3375 SOME NEW ASPECTS OF COLOR PERCEPTION.

M.M.Woolfson.

I.B.M. J. Res. Developm., Vol. 3, No. 4, 313-25 (Oct., 1959).

A mathematical analysis is made of Land's recent experiments (see preceding abstracts), which showed that fully coloured pictures can be produced by a two-colour projection system. Although Land's results apparently had been at variance with the classical theories of colour perception, it has now been found possible to explain the experiments within the framework of those theories and in conjunction with well-known phenomena in the field of experimental psychology. The results are interpreted in terms of a mechanism of colour transformation.

612.8 : 77

3376 EXPERIMENTS IN COLOUR VISION.

E.H.Land.

Uspekhi fiz. Nauk, Vol. 70, No. 1, 167-84 (Jan., 1960). In Russian.

A translation into Russian of Land's paper in "Scientific American", (see preceding abstracts).

612.8

3377 CASE OF CONGENITAL TRITANOPIA WITH IMPLICATIONS FOR A TRICHROMATIC MODEL OF COLOR RECEPTION. H.G.Sperling.

J. Opt. Soc. Amer., Vol. 50, No. 2, 156-63 (Feb., 1960).

The luminous efficiency of the spectrum, dichromatic coefficients, spectral colour confusions, and matches of spectral to pigment colours were obtained on a congenital tritanope. The results are compared with those obtained by Wright (Abstr. 7785 of 1952) and by Thomson and Wright (Abstr. 951 of 1954). The conclusion is drawn that a point close to the spectrum locus in the violet region of the normal chromaticity plane has been reliably located as representing a "missing" receptor process, according to the Helmholtz theoretical development. The possible implications of this finding are pursued with reference to the theoretical primary receptor functions of normals and the question of a theoretically derived equal chromaticity space.

612.8

3378 SOME FACTORS DETERMINING THE MAXIMUM ANGULAR VELOCITY OF PURSUIT OCULAR MOVEMENTS. B.Bhatia.

J. Opt. Soc. Amer., Vol. 50, No. 2, 149-50 (Feb., 1960).

The present investigation aims at the determination of the influence of the distance between the observer and a moving object and of the size of a slit in front of the object, on the maximum angular velocity of pursuit ocular movements. The latter was indirectly computed from the maximum linear velocity at which an individual is just able to recognize the smallest resolvable details of the object moving in a vertical plane. The results indicate that the maximum angular velocity of eye movements is equal to 57.3 s/d (bs + a) where s = vertical dimension of slit, d = distance between the observer and the moving object, and b and a are constants for the individual. It is concluded from the above relationship that s and d independently influence the maximum angular velocity of eye movements and not by altering the pattern of image on the retina. The results confirm the hypothesis that the maximum angular velocity

of eye movements is related to the perceived dimensions of the slit. Further, it is postulated that the visual cues for distance perception are responsible for the inverse linear relationship between the response of the eyes to a given stimulus pattern in the psychovisual cortex and the distance of the observer from the object.

612.8

3379 PHOTOELECTRIC TECHNIQUE FOR MEASURING EYE MOVEMENTS. W.M.Smith and P.J.Warter, Jr.
Science, Vol. 130, 1248-9 (Nov. 6, 1959).

By the system described, the movement of a stimulus and the correlated tracking movements of the eye are recorded simultaneously. The technique for measuring the eye movements consists of detecting and amplifying by photomultiplication the total amount of light passing through a small slit upon which is imaged a small portion of the light-dark field represented by the iris and sclera of the eye. This total amount of light varies directly with the angular position of the eye.

612.8

3380 EYE MOVEMENT AND STIMULUS MOVEMENT; NEW PHOTOELECTRIC ELECTROMECHANICAL SYSTEM FOR RECORDING AND MEASURING TRACKING MOTIONS OF THE EYE. W.M.Smith and P.J.Warter, Jr.
J. Opt. Soc. Amer., Vol. 50, No. 3, 245-50 (March, 1960).

A new technique of eye-movement measurement based upon a photoelectric principle is described. An image of a small portion of the eye at the juncture of the iris and sclera is cast upon a surface containing a small horizontal slit. Behind the slit is located the photocathode of a photomultiplier tube. As the eye rotates on its vertical axis more or less of the sclera (or iris) falls upon the slit, and hence more or less total light reaches the photosensitive element of the tube. The output of the tube thus can be related directly to the angular position of the eye. A system for generating a moving target whose velocity, displacement, form intensity, and other characteristics can be varied systematically also is described. This system is coupled to that for measuring eye movements with the result that both the signal for eye movement and the signal for the movement of the stimulus can be displayed and recorded simultaneously on an oscilloscope. Consequently, both signals can be studied in detail as a function of time, and in relation to one another. Eye movements of less than one degree can be measured with less than 1% error. Optical modifications of the present system will make possible the measurement of much smaller movements of the eye. Extensions and improvement of the technique of measurement are discussed briefly.

612.8

3381 EFFECT OF DIFFERENTIAL BINOCULAR ADAPTATION ON SCOTOPIC ACUITY. S.M.Luria and I.Schwartz.
J. Opt. Soc. Amer., Vol. 50, No. 3, 251-3 (March, 1960).

Monocular scotopic acuity thresholds were determined for three observers when both eyes were dark adapted and also when only the observing eye was dark and adapted while the nonobserving eye was exposed to a brightness of 100 ft-L between the target presentations. Although the observers reported that the targets looked quite different under the two conditions, acuity remained substantially the same under both conditions, and it was concluded that light adapting one eye does not affect the scotopic acuity of the other eye.

612.8

3382 SEASONAL CHANGES IN SCOTOPIC SENSITIVITY. E.J.Sweeney, J.A.S.Kinney and A.Ryan.
J. Opt. Soc. Amer., Vol. 50, No. 3, 237-40 (March, 1960).

The scotopic sensitivity of three subjects was tested weekly over the course of a year. In addition, two measures were made to indicate each subject's amount of exposure to sunlight. Scotopic sensitivity was found to be poorest in the summer months, when exposure to sunlight was greatest, and to increase gradually during the fall and winter. The course of sensitivity over the year agreed with the external measures of exposure to sunlight, the best single measure being the amount of "blue" light reflected by the skin.

612.8

3383 EQUIVALENCE OF VARIOUS PULSE-TO-CYCLE FRACTIONS IN PRODUCING CRITICAL FLICKER FREQUENCY. S.H.Bartley and T.M.Nelson.
J. Opt. Soc. Amer., Vol. 50, No. 3, 241-4 (March, 1960).

An earlier investigation of the senior author suggested very strongly that various quite different P.C.F.'s (pulse-to-cycle fractions) were, under some conditions, equivalent in producing C.F.F. This was contrary to common expectation, and was not fully confirmed by the scant amount of data then obtained. The present study consisted of testing the earlier suggestions by the use of seven observers using one method, and two observers using a second method of collecting data. The C.F.F.'s for each of the following P.C.F.'s, 1/30, 1/8, 1/4, 1/2, 3/4, 7/8, and 29/30, were obtained as the photic intensity was varied. Two ranges were studied from 1.28 to 1164 c/ft^2, and from 0.014 to 1400 c/ft^2. The data produced families of curves, one curve for each P.C.F. Some pairs of these curves crossed each other, the points of crossing indicating that, under those conditions, two P.C.F.'s were equivalent.

612.8

3384 PHYSIOLOGICAL NYSTAGMUS IN THE CAT. F.W.Hebbard and E.Marg.
J. Opt. Soc. Amer., Vol. 50, No. 2, 151-5 (Feb., 1960).

Cats were prepared by the encephale isole technique. A small plane-mirror mount was sutured to each cornea without obstructing vision, and eye movements were recorded using the optical-lever method. The records showed physiological nystagmus similar to that in man, although the cats had fewer and smaller saccades. Some saccades were binocular, but usually they were uniocular. The fine tremor varied in frequency from 35-65 c/s, averaging 50 c/s, and in amplitude from 4-52 sec of arc, averaging 22 sec. Curare decreased and ultimately abolished eye movements and physiological nystagmus, whereas neostigmine increased them. Physiological nystagmus is therefore mediated by efferent neural stimulation of the eye muscles. Tremor was also recorded from the detached inferior oblique muscle, as well as from the eyeball with most of the extraocular muscles detached. Fine tremor was also found in finger pointing in man. The significance of physiological nystagmus to vision is briefly discussed.

TECHNIQUE . MATERIALS

62

3385 ON THE STRENGTHENING OF HIGH PRESSURE VESSELS.
M.G.Gonikberg, D.S.Tsiklis and A.A.Opekunov.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 1, 88-90 (Nov. 1, 1959). In Russian.

The authors describe an instrument designed to measure deformation and elastic strength of vessels under high internal pressures. The vessels used were constructed on the tetrahedric anvil principle, as suggested by Hall (Abstr. 4613 of 1958).

J.K.Skwirzynski

62

3386 NONMAGNETIC HIGH-PRESSURE VESSELS.
W.Paul, G.B.Benedek and D.M.Warschauer.
Rev. sci. Instrum., Vol.30, No.10, 874-80 (Oct., 1959).

The use of berrylium–copper and stainless steel in the construction of pressure vessels to contain 20 000 kg/cm^2 is described. Machine drawings are given for the construction of different types of pressure vessel, different types of seal, and methods of introducing electrical leads into the apparatus. Experience in the use of high-pressure vessels and plugs beyond the elastic limit of the construction materials is reviewed.

62

3387 USE OF CESIUM CHLORIDE FOR TRANSMITTING HIGH PRESSURES AT HIGH TEMPERATURES.
H.W.Schamp, Jr.
Rev. sci. Instrum., Vol. 30, No. 11, 1051-2 (Nov., 1959).

The advantage of CsCl as pressure medium over other alkali-halides lies in its plasticity, its melting point which is higher at ordinary pressures and increases more rapidly with pressure than that of most other alkali-halides, and the ease with which special shapes can be pressed from powder form. Application has been to diffusion experiments in KCl in the range 1 to 16 000 atm and up to 1100°C. Two schematic diagrams of the apparatus are given.

F.Ansbacher

62

3388 GRINDER FOR SECTIONING SOLID DIFFUSION SPECIMENS.
H.W.Schamp, Jr., D.A.Oakes, and N.M.Reed.
Rev. sci. Instrum., Vol. 30, No. 11, 1028-31 (Nov., 1959).

A grinder which can be used for sectioning diffusion specimens in which the average diffusion distance is a very few microns is described. Three fixed steel balls are used to determine the grinding plane of the instrument, and the specimen is held with constant orientation at the centre of the triangle formed by the balls. The orientation of the grinding plane with respect to the specimen surface can be changed to make the two parallel by adjusting the lengths of the legs to which the steel balls are attached. These lengths can be adjusted over several cm, permitting a large variation in specimen thickness and orientation. A differential screw arrangement on each leg makes it possible to orient the grinding plane and crystal surface to within 5×10^{-6} radian with respect to one another. The shaft on which the specimen remains mounted during the entire grinding procedure can be moved in a line perpendicular to the grinding plane so that the specimen surface protrudes beyond the grinding plane. A solid grinding plate is then used to grind the specimen away until the surface lies in the plane. Since no loose grinding compound is used, the material removed from the specimen can easily be collected for preparing a radioactive slide. It is also possible to assay the radioactivity of the specimen itself. The motion of the shaft, and, consequently, the thickness ground away, is measured directly using an electronic indicator and is checked every 10μ against gauge blocks. It is estimated that sections parallel to within 10^{-5} radian and with the thickness known to the order of a few hundredths of a micron can be removed with the device, the lower limit on the thickness of the slice being about 1μ.

62

3389 HANDLING OF EXTREMELY THIN WOLLASTON WIRES. H.J.Bomelburg.
Rev. sci. Instrum., Vol. 30, No. 12, 1114-15 (Dec., 1959).

A reliable method of etching and mounting Wollaston wires is described. The method involves attaching one end of the wire to a specially prepared ceramic tube, dipping the pendant portion of the wire into an etching solution, and then after etching is completed, attaching the loose end of the wire to the ceramic tube, and finally, firing the tube and mounted wire to 1000°F. The thinnest wires handled by this method had diameters of 0.5μ and lengths of 2 mm.

621.9 : 534.2

3390 THE EFFECT OF CAVITATION ON ULTRASONIC MACHINING OF SOLIDS. N.M.Rostovtsev.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 6, 1210-12 (Aug. 21, 1959). In Russian.

It is shown that occurrence of cavitation in the suspension of abrasive powder surrounding the solid decreases the rate of machining.

J.Jarzynski

66

3391 DIAMOND. I.
S.Tolansky.
Contemporary Physics, Vol. 1, No. 2, 96-111 (Dec., 1959).

A review is given of the hardness of diamond, its sources, its fabrication and of many of its uses as a technological material. Some examples of etched diamond surfaces, growth features, surface polish and percussion marks are illustrated. The history of man-made diamonds is briefly reviewed.

66 : 539.17

3392 THE METALLURGY OF URANIUM BY THE NATIONAL COMMITTEE FOR NUCLEAR RESEARCH. A.Cacciari.
Nuovo Cimento Suppl., Vol. 11, No. 3, 366-75 (1959). In Italian.

Research into an economic fuel cycle has been centred on the development of an economical process for production of uranium metal and the design of prototype fuel elements. After investigation of various fluoridation and reduction methods, a pilot plant producing 40 kg of uranium a day has been built. In this $NaUF_5$ is precipitated with aqueous HF, dried and reduced with magnesium. Research into fuel elements has concentrated on the problem of producing a fine-grained metal. This can be achieved by the addition of a small quantity of an alloying element such as Zr, Mo, and Ni. Ceramic elements have also been considered. UO_2 has a good radiation resistance and methods of preparation giving a suitable porosity have been studied.

R.D.Smith

669 : 539.8

THE DIFFUSION THEORY OF SINTERING. See Abstr. 3167

664

3393 CONTROLLED ATMOSPHERE LEVITATION SYSTEM.
B.Harris and A.E.Jenkins.
J. sci. Instrum., Vol. 36, No. 5, 238-40 (May, 1959).

A levitation system designed to melt and cast small quantities of metals under controlled-atmosphere conditions is described. Temperature control of the levitated sample and certain other practical aspects of the technique are discussed on the basis of experience gained over a two-year development period.

LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 62 (1959). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

J. Soc. Glass Technol.	Journal of the Society of Glass Technology. Now published in two Sections: Glass Technology (Section A) and Physics and Chemistry of Glasses (Section B).
Ricerche spettrosc.	Ricerche Spettroscopische. Specola Vaticana, Vatican City.

NEW JOURNAL

Phys. Chem. Glasses	Physics and Chemistry of Glasses Society of Glass Technology, Thornton, Hallam Gate Road, Sheffield 10. Bi-monthly. Vol. 1, No. 1 dated Feb., 1960.

ERRATA

Abstr. 2038 (1959) line 2: for "W.Zimmerman" read "W.Zimmermann".
Author Index (1959) p. 1521, column 1: for "Walker,R.E. and Westerberg,A.A." read "Walker,R.E. and Westenberg,A.A.".
Abstr. 847 (1960): add Abstractor's signature "A.H.Gabriel".
Abstr. 1089 (1960) line 3: for "1870-5" read "1870-3".
Abstr. 1313 (1960) line 3: for "Landowitz" read "Landovitz".

AUTHOR INDEX

AUTHOR INDEX

AUTHOR INDEX

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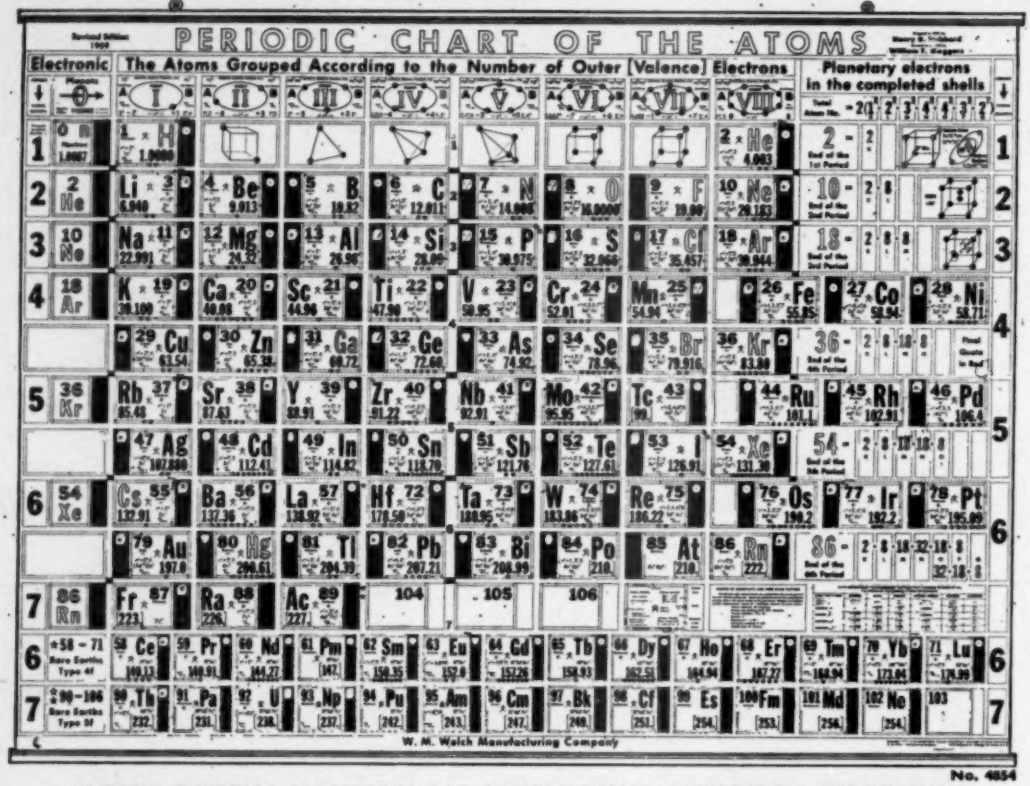

No. 4854

LATEST OFFICIAL DATA ON ALL 102 ELEMENTS THROUGH NOBELIUM

Prepared under the editorial supervision of
DR. WILLIAM F. MEGGERS, NATIONAL BUREAU OF STANDARDS

The Periodic Chart of the Atoms, published exclusively by Welch, is recognized throughout the world as a most authoritative and comprehensive presentation of the principal facts about all known atoms, including artificial transuranic elements recently manufactured.

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